CALIFORNIA HIGH-SPEED RAIL AUTHORITY

TASK 1.5.2
ALIGNMENT/STATION SCREENING EVALUATION METHODOLOGY

CALIFORNIA HIGH-SPEED RAIL PROGRAM MANAGEMENT CONTRACT

FINAL

Prepared for:

California High-Speed Rail Authority

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EXECUTIVE SUMMARY

Within the overall High-Speed Train System Alternative, there will be a range of alignment and station location options to be considered. The majority of these options have been evaluated in previous studies and have been presented to the previous Intercity High-Speed Ground Transportation Commission and the current High-Speed Rail Authority. Some options were carried forward for further consideration and other options were removed from further consideration, based on their relative merit and viability for potential implementation as part of a statewide high-speed train system. The purpose of the high-speed train alignment/station screening evaluation is to consider all reasonable and practical alignment and station options at a consistent level of analysis and focus the program environmental analysis on the most viable of these alignment and station options. This alignment and station screening process and information differentiating the most viable options will be presented to the Authority in June 2001.

This alignment and station screening evaluation will be accomplished through the following key activities.

- Review the alignment and station options previously studied and confirm or reconsider past screening decisions.
- Identify and evaluate alignment and station options not previously evaluated. These options may be identified through the scoping process and/or through review and analysis of the current conditions in specific segments of the proposed system.
- Using standardized criteria adopted by the Authority, evaluate alignment and station options to identify those with fatal flaws or with inherent limitations and constraints that would significantly limit their viability for high-speed train implementation. The evaluation will address environmental, engineering, financial, and institutional issues.
- Screen the options based on their relative merit and viability as part of the proposed statewide high-speed train system and recommend the most viable options for further study as part of the program environmental process.

The objectives, parameters, criteria and methodologies described in this report are consistent with those approved by the Authority in the previous Corridor Evaluation Study. The intent of this screening evaluation is to consider the alignment and station options at a broad level of analysis in order to move efficiently toward more detailed consideration of the most viable options.

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1.0 INTRODUCTION

Since 1992, extensive information has been gathered and preliminary evaluation has been completed concerning the potential environmental effects associated with numerous high-speed rail corridor alternatives throughout California. From feasibility studies through conceptual design, a variety of technical studies have been undertaken to address the engineering, operational, financial, ridership, and environmental aspects of such a system. The findings of these studies concluded that California would benefit substantially from high-speed rail transportation. Because of the anticipated benefits and the proven need for additional transportation options, the further evaluation of a high-speed train system is seen as the next logical step in the development of California's transportation infrastructure.

The current stage of project development for a statewide high-speed rail system is designed to further optimize alignments, avoid/minimize environmental impacts, and develop a more accurate cost figure based on a more refined level of engineering and environmental analysis. As such, the California High-Speed Rail Authority (Authority) has initiated a formal environmental clearance process through the preparation of a state program-level Environmental Impact Report (EIR) and a federal Tier I Environmental Impact Statement (EIS) or Program EIR/EIS.

1.1 BACKGROUND

The California Intercity High-Speed Rail Commission (Commission) was established in 1993 by Senate Concurrent Resolution (SCR) 6 to investigate the feasibility of high-speed rail (~~HSR~~HIGH-SPEED TRAIN) for California, specifically, a system connecting the San Francisco Bay Area, Los Angeles, San Diego, and Sacramento. To address this question of feasibility, the Commission successfully conducted a series of technical studies encompassing ridership and revenue forecasts; economic impact and benefit cost analyses; institutional and financing options; corridor evaluation and environmental impacts and constraints analyses; and preliminary engineering feasibility studies. Based on these studies, the Commission determined that ~~HSR~~a high-speed train system is technically, environmentally, and economically feasible and set forth recommendations for the technology, corridors, financing, and operation for this system.

The California High-Speed Rail Authority was created by the state Legislature in 1996 (Chapter 796 of the Statutes of 1996 — Senate Bill 1420, Kopp and Costa) to be an implementing agency that would construct, operate, and fund a statewide, intercity high-speed passenger rail system. Based on recently completed studies, evaluations, and previous analysis, the Authority has developed a plan to implement a statewide high-speed train system in California. The current proposal is presented in the Authority's Business Plan. The plan describes a 700-mile (1,126-kilometer) -long system capable of speeds in excess of 200 miles per hour (mph) (320 kilometers per hour [km/h]) on dedicated, fully grade-separated tracks with state-of-the-art safety, signaling, and automated train control systems. The system would serve the major metropolitan centers of California.

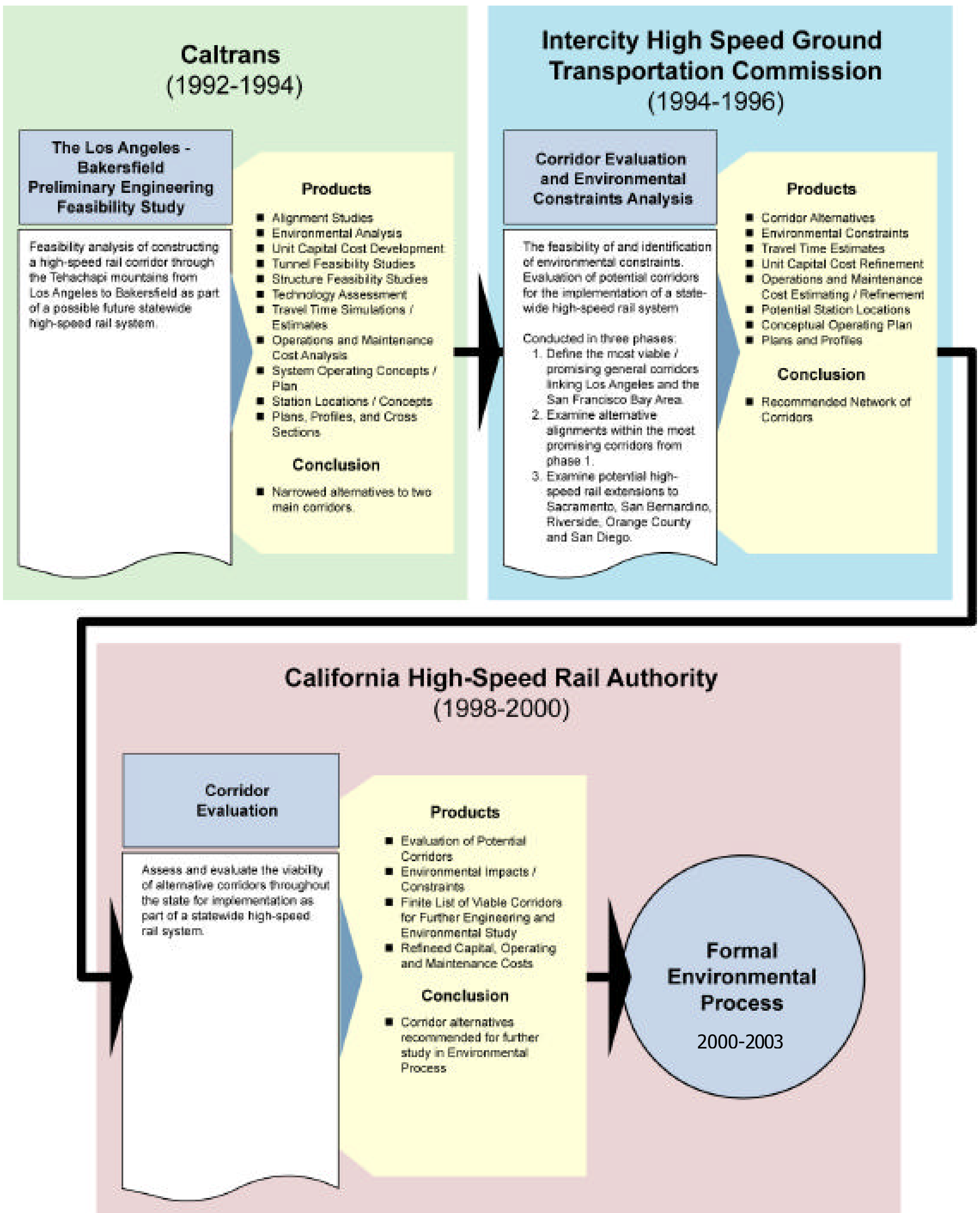
1.1.1 Past Studies

Beginning in 1992, three planning and engineering studies have been completed under the direction of the California Department of Transportation (Caltrans), the past Commission, and the current Authority. While the studies differed in terms of their specific scopes of work, they all shared the common focus of identifying potential corridors for the implementation of ~~HSR~~high-speed train lines and evaluating the feasibility and viability of these corridors.

Analysis of environmental constraints through use of existing databases and identification of potential impacts were key components of these studies. The studies were completed in consecutive order, allowing for each subsequent study to benefit from, and build on, the work completed in the prior study. In each study the number of corridor options was reduced. Public involvement was an important part of the feasibility studies. The public was updated on the study progress and key decision points with newsletters and access to the website. The work from previous studies allowed for the remaining corridors to be further refined and developed in the subsequent study. Each of the three studies is described in the California High-Speed Rail Corridor Evaluation - Environmental Summary Report (April 2000). The studies and their interrelations are also presented in Figure 1.1-1. It is important to note that several other studies and analyses were also completed, under the direction of the Commission and Authority, pertaining to ridership, financing, public outreach, and economic impacts.

Figure 1.1-1

Flow Chart – California High-Speed Rail Studies



LOS ANGELES – BAKERSFIELD PRELIMINARY ENGINEERING FEASIBILITY STUDY (1994)

Completed in 1994, this study analyzed the feasibility of constructing a ~~HSR~~high-speed train crossing of the Tehachapi Mountains in Southern California. After considering a broad range of alternative alignments, the study focused on the most viable routes. Two main corridors between Los Angeles and Bakersfield were considered feasible in terms of cost, travel time, and environmental impact: I-5 Grapevine and Palmdale-Mojave. The corridors studied traversed a variety of terrain (urban development, mountains, valley floor, etc.), allowing the engineering and costing analyses to be applicable to other portions of the state. Because of this applicability, work performed for the Los Angeles–Bakersfield study provided an important foundation for the subsequent statewide corridor evaluation studies.

CORRIDOR EVALUATION AND ENVIRONMENTAL CONSTRAINTS ANALYSIS (1996)

This study was conducted in three phases and was completed in 1996. The first phase defined the most promising corridor alignments for linking the San Francisco Bay Area and Los Angeles. During the second phase, these alternative corridors between Los Angeles and the Bay Area were examined in more detail. The third phase examined potential ~~HSR~~high-speed train system extensions to Sacramento, San Bernardino/Riverside, Orange County, and San Diego. The study identified station locations and estimated travel times; developed construction, operation, and maintenance cost estimates; analyzed environmental constraints and possible mitigation measures; and, in an iterative process with the Ridership Study, developed a conceptual operating plan. The corridors recommended for further study in Phases 2 and 3 were refined in the corridor evaluation studies completed by the Authority.

CALIFORNIA HIGH-SPEED RAIL CORRIDOR EVALUATION (2000)

In September of 1998, the Authority commissioned a Corridor Evaluation study to assess and evaluate the viability of various corridors throughout the state for implementation as part of a statewide ~~HSR~~high-speed train system. To address new issues raised by local and regional agencies, further corridor investigations and evaluations were conducted in several areas of the State and compared in the context of updated information on previously studied routes. The Authority was mandated to move forward in a manner that was consistent with, and continued the work of the Commission. Using the Commission's recommended corridors as a foundation, potential corridors were further evaluated on the basis of capital, operating and maintenance costs; travel times; and engineering, operational, and environmental constraints. The corridors were compared and evaluated on a regional basis and as part of a statewide system. From this study, the Authority identified corridors to be included in the current stage of project development as part of the Program EIR/EIS.

1.2 PROGRAM ENVIRONMENTAL PROCESS

The overall project development process can best be summed up as being in four main stages.

- Stage A: Feasibility Studies (previous studies discussed above)
- **Stage B: Program Environmental Document (current project)**
- Stage C: Project-Specific Environmental Document(s)
- Stage D: Design/Construction/Procurement/Testing and Commission

The current stage of planning, as discussed above, is to prepare a Program EIR/EIS to satisfy the requirements of the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) for the first tier of environmental review. This stage is anticipated to take approximately three years to complete. In the Program EIR/EIS stage, the Authority is addressing both CEQA and NEPA requirements simultaneously. The purpose of utilizing a program or tiered environmental review is to formally engage resource agencies and the public in the consideration of alternatives and potential impacts and benefits of high-speed rail as part of the California transportation system and to develop mitigation strategies for potential impacts.

The key elements of the Program Environmental Document stage include: high-speed rail alignment and station screening evaluation; conceptual engineering at a 5 to 10 percent level of detail; operations analysis; environmental impact analyses (consistent with the level of engineering design); proactive resource agency involvement to provide early input on alternatives and potential mitigation; and formal public and agency involvement. At the end of the Program Environmental Document stage, the Authority, state and federal agencies, and the public will have the required technical analyses to make an informed decision on alignment alternatives and station locations to be carried forward to more detailed engineering and focused environmental analysis. In conjunction with the Program Environmental Document, an Implementation Plan will be prepared identifying future projects that are part of an overall phased statewide high-speed rail system.

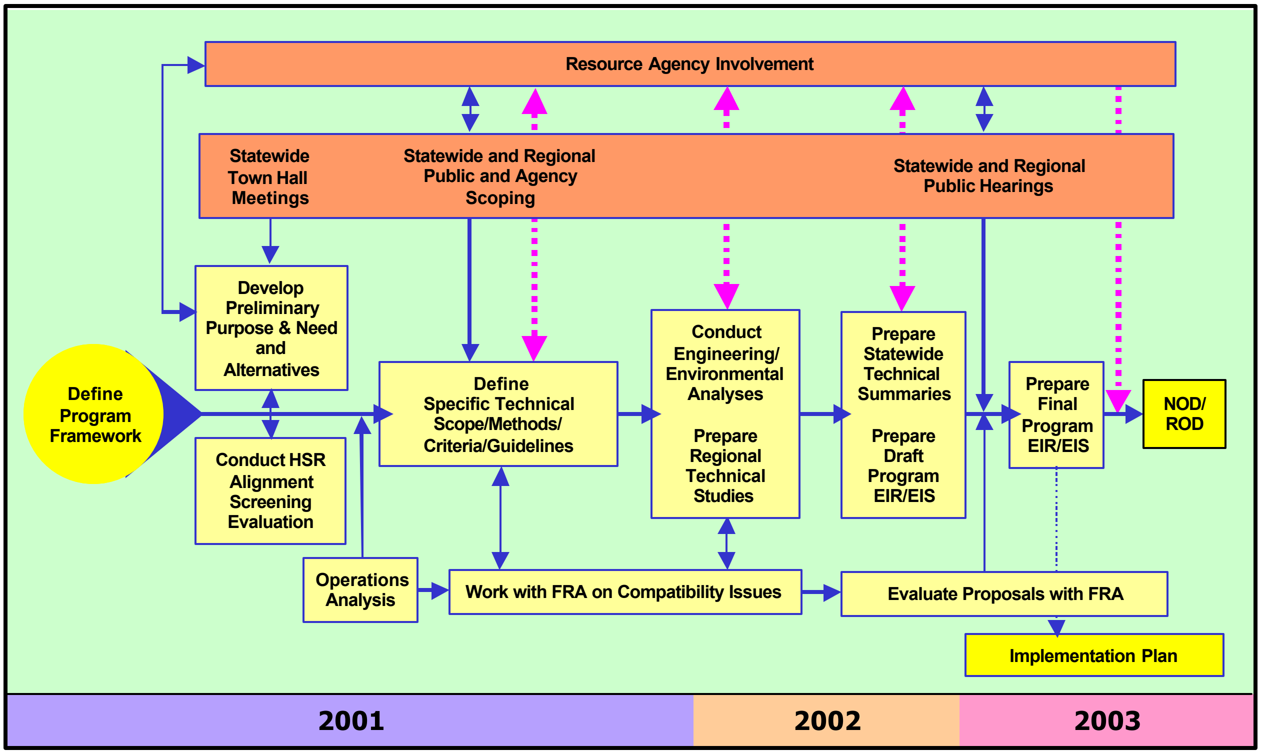
At the conclusion of the Program Environmental Document stage, these future projects could move forward to the next stage of the project development process. The Project-Specific Environmental Document(s) stage would include conducting preliminary engineering (15 to 30 percent design) and project-specific environmental review for the alignment and stations and operating alternatives. The project-specific phase will be accomplished incrementally, with priority placed on segments for early implementation, and is anticipated to take approximately four years. Once environmental clearances have been obtained for these projects and funding has been established, the projects would move to the Design/Construction/Procurement/Testing and Commission stage. During the Design/Construction/ Procurement/Testing and Commission stage, the Authority would secure design-build or design-build-operate-maintain contracts to start construction and procurement. This final implementation phase will be accomplished incrementally, with key segments being constructed and opened for operation first.

1.2.1 Program EIR/EIS Workflow

The program workflow, as illustrated in Figure 1.2-1, is focused on environmental clearance at a program level for the five regions that would makeup the overall statewide high-speed rail system. The process has inherent streamlining elements intended to provide the ability to meet the three-year schedule for completing the Program EIR/EIS and to reduce the time required for the overall environmental approval and permitting process. Among the key elements of the workflow is the early screening of high-speed rail alignments. The overall Program EIR/EIS process includes the following elements:

- Program Framework
- Resource Agency Involvement
- Public and Agency Involvement
- Preliminary Purpose and Need Statement and System Alternatives
- Regional High-Speed Rail Alignment Screening Evaluation
- Operations Analysis
- Technical Scope/Methods/Guidelines
- Compatibility Coordination
- Regional Engineering/Environmental Analyses and Technical Studies
- Draft Program EIR/EIS
- Final Program EIR/EIS
- Notice of Determination/Record of Decision
- Implementation Plan

Figure 1.2-1
Program EIR/EIS Workflow



1.3 PURPOSE OF ALIGNMENT SCREENING EVALUATION

As part of the program environmental process, a number of overall system modal alternatives (no-build, air, highway, rail) will be considered and compared to the proposed ~~HSR~~high-speed train system. Within the overall ~~HSR~~ High-Speed Train~~System~~ Alternative, there will be a range of alignment and station location options to be considered. The majority of these options have been evaluated in previous studies and have been presented to the previous Intercity High-Speed Ground Transportation Commission and the current High-Speed Rail Authority. Some options were carried forward for further consideration and other options were removed from further consideration, based on their relative merit and viability for potential implementation as part of a statewide ~~HSR~~high-speed train system. The purpose of the Alignment Screening Evaluation is to consider all reasonable and practical alignment and station options at a consistent level of analysis and focus the program environmental analysis on the most viable of these alignment and station options. This screening process and information differentiating the most viable options will be presented to the Authority in June 2001.

This screening evaluation will be accomplished through the following key activities.

- Review the alignment and station options previously studied and confirm or reconsider past screening decisions.

- Identify and evaluate alignment and station options not previously evaluated. These options may be identified through the scoping process and/or through review and analysis of the current conditions in specific segments of the proposed system.
- Using standardized criteria adopted by the Authority, evaluate alignment and station options to identify those with fatal flaws or with inherent limitations and constraints that would significantly limit their viability for ~~HSR~~high-speed train implementation. The evaluation will address environmental, engineering, financial, and institutional issues.
- Screen the options based on their relative merit and viability as part of the proposed statewide ~~HSR~~high-speed train system and recommend the most viable options for further study as part of the program environmental process.

The objectives, parameters, criteria, and methodology described in this report are consistent with those applied in previous California ~~HSR~~high-speed train studies. The intent of this screening evaluation is to consider the options at a broad level of analysis in order to move efficiently toward more detailed consideration of the most viable options.

In the following chapters, this report describes the context, parameters, standardized criteria, and methods to be applied in this screening evaluation. Chapter 2.0 describes the proposed ~~HSR~~ High-Speed Train Alternative in terms of general corridors and stations, performance criteria and performance goals. Chapter 3.0 describes the engineering assumptions and parameters to be used in developing alignments and stations. Chapter 4.0 describes the evaluation objectives and criteria and methodologies to be applied in the evaluation of alignments and stations. Chapter 5.0 describes the documentation required for this screening process and provides consistent organizational and format direction for each of the Regional Consultant Teams.

2.0 PROGRAM DESCRIPTION

The Authority has defined the California High-Speed Rail Program in terms of the general corridors and stations to be considered and the performance goals and criteria on which to base the development and evaluation of alternatives (Authority Resolution, December 2000).

2.1 BASELINE CORRIDORS AND STATIONS

The Authority has defined alternative corridors for consideration in the preparation of a program EIR/EIS (Authority Resolution 99-5, July 1999). Figure 2.1-1 illustrates the corridors and potential station locations to be evaluated. These corridors and station locations are defined below, by region.

2.1.1 Corridors

SAN DIEGO TO LOS ANGELES

Mainline service connecting Los Angeles and San Diego will follow either an inland route (along existing transportation corridors) and/or a coastal route (along the existing LOSSAN corridor). The inland route runs from Los Angeles Union Station to Riverside along existing rail corridors and new rights-of-way. Mainline service continues from Riverside to San Diego along the I-15/I-215 Corridor. The coastal route extends from Los Angeles Union Station to San Diego along the existing LOSSAN rail corridor. A link between Los Angeles Union Station and Los Angeles International Airport (LAX) will also be considered as part of this study.

Figure 2.1-1
HSR Corridors and Station Locations

LOS ANGELES TO BAKERSFIELD

From Los Angeles Union Station to Santa Clarita, existing rail corridors would be followed. There are two corridors crossing the Tehachapi Mountains; the first joins Bakersfield to Los Angeles via the I-5 Grapevine Corridor, and the second would connect Bakersfield and Los Angeles through the Antelope Valley (Palmdale).

SACRAMENTO TO BAKERSFIELD

Between Sacramento and Bakersfield, specific options to be evaluated should minimize impacts to prime agricultural lands; utilize existing rail corridors; and serve downtown stations or airports in Bakersfield and Fresno.

MERCED TO THE BAY AREA

From the vicinity of Merced in the Central Valley, the alignment follows the Pacheco Pass to Gilroy. From Gilroy to San Jose, the alignment follows the existing Caltrain and Amtrak coastal corridor. North of San Jose, mainline service will continue to follow the existing Caltrain corridor along the peninsula to San Francisco and/or existing rail corridors in the East Bay to Oakland.

2.1.2 Stations

LOCATION

The following potential station locations (also shown on the map above) were defined in previous planning and engineering studies: San Diego, Mira Mesa, Escondido, Temecula, Riverside, Ontario International Airport (ONT), East San Gabriel Valley, University Town Center (La Jolla), Oceanside, Irvine, Anaheim, Norwalk, Los Angeles International Airport (LAX), Los Angeles Union Station, Burbank, Santa Clarita, Palmdale, Bakersfield, Tulare County/Visalia, Fresno, Merced, Modesto, Stockton, Sacramento, Los Banos, Gilroy, San Jose, Redwood City, San Francisco International Airport (SFO), San Francisco, Fremont/Newark, Oakland International Airport (OAK), and Oakland. The potential sites listed represent general locations for planning purposes. Specific siting for stations will be refined through the program environmental process. Station placement will be determined based on ridership potential, system-wide needs, and local planning constraints/conditions. Station placement will be coordinated with local and regional planning agencies, and will provide for seamless connectivity with other modes of travel.

CONFIGURATION

There are two principal types of stations: terminus and intermediate. Terminus stations are those where all trains are planned to stop. San Diego, Los Angeles Union Station, LAX, San Francisco, Oakland, and Sacramento are all planned as terminus stations. All other potential stations are intermediate stations. Intermediate stations will provide off-line passenger platforms allowing for pass-through express services on the dual track mainline.

PASSENGER AMENITIES

The specific features and amenities will vary between stations, depending on passenger demand and station type (i.e., terminal or intermediate). Amenities should be focused on convenience and ease of transfer to and from other modes of transportation.

2.2 PERFORMANCE CRITERIA

The Authority adopted the following performance criteria for a very high-speed rail system as part of the High-Speed Rail Corridor Evaluation Technical Memorandum 2.0 in January 1999.

2.2.1 System Design Criteria

- Electric propulsion system.
- Fully grade-separated guideway.
- Fully access-controlled guideway with intrusion monitoring systems.
- Track geometry must maintain passenger comfort criteria (smoothness of ride, lateral acceleration less than 0.1g).

2.2.2 System Capabilities

- All Weather/All Season Operation.
- Capable of sustained vertical gradient of 3.5 percent without significant degradation in performance.
- Capable of operating parcel and special freight service as a secondary use.
- Capable of safe, comfortable and efficient operation at speeds of over 200 mph (320 km/h).
- Capable of maintaining operations at three-minute headways.
- High-capacity and redundant communications systems capable of supporting fully automatic train control.

2.2.3 System Capacity

At a minimum, the system infrastructure must include dual track/guideway mainline with off-line station stopping tracks and other special trackwork as required for safe and efficient operation. The system must be capable of accommodating a wide range of passenger demand (up to 26,000 passengers per hour per direction). The system must accommodate normal maintenance activities without disruption to daily operations.

2.2.4 Level of Service

The Authority adopted the following level-of-service criteria established for a very high-speed rail system as part of the ridership and revenue assumptions in September 1999:

TYPES OF SERVICE

- Express: trains running from Sacramento, San Jose or San Francisco to Los Angeles and San Diego without intermediate stops.
- Semi-Express: trains running between similar endpoints as express but with some intermediate stops (e.g., Bakersfield, Fresno).
- Suburban-Express: trains stopping at urban and suburban stations within the major metropolitan regions, but running as an express train between the regions.
- Local: trains serving every station.
- Long-Distance Commute: trains providing service from suburban and outlying stations within a region to the urban centers in that region (e.g., Temecula to Los Angeles).

FREQUENCIES

To the extent possible, trains should be scheduled according to clock-face departure times (e.g., express service from Los Angeles, every hour on the hour). In general, train service characteristics will be based on actual market demand. System operating capabilities allow for flexibility in meeting market demands with up to three-minute headways.

2.3 PERFORMANCE GOALS

2.3.1 Mobility

- Provide a safe, interconnected statewide transportation system for California's citizens and visitors that ensures the mobility of people and goods, while enhancing economic prosperity and sustaining the quality of the environment.
- Enhance efficient operation of transportation facilities and service between the major urban areas of San Diego, Los Angeles, the Central Valley, San Jose, Oakland/San Francisco; and Sacramento.
- Provide a high-speed travel alternative that minimizes travel time between destination points (total trip time) to maximize ridership.
- Ability to carry the forecasted ridership by 2020 and to accommodate future growth through 2050.
- Maximize intermodal connections (airports, commuter rail, light rail).
- Maximize flexibility to meet changing market demand.

2.3.2 System Safety/Reliability

- 98 percent On-Time Arrivals (on-time: +/- one minute from schedule).
- Identify means for use of shared rights-of-way.
- Maximize safety in the design and operational characteristics of the system.
- Design for minimal damage and operational disruption from maximum probable seismic events.

2.3.3 Environment

- Minimize relocation/property acquisition.
- Minimize disruption to neighborhoods and communities.
- Minimize impacts to parklands.
- Compatible with State Transportation Improvement Program (STIP), Regional Transportation Improvement Program (RTIP), and Metropolitan Planning Organization plans.
- Avoid/minimize impacts to historic properties and archaeological resources.
- Maximize reductions of mobile emissions by reducing vehicle miles traveled, particularly in and between urban areas having ozone ordinances.
- Powered by fuels that result in zero emissions.
- Minimize impacts to wetlands and sensitive habitats for threatened and endangered species.
- Avoid or minimize inclusion of public lands and/or natural conservation areas.
- Consider Environmental Justice Issues in selecting corridors.

2.3.4 Travel Times

Representative travel time goals are presented in Table 2.3-1 to guide the consideration of alignment evaluation and system performance/capabilities.

Table 2.3-1
Travel Time Goals (Express Service)

City Pair	Antelope Valley Corridor (hours: minutes)	I-5 Grapevine Corridor (hours: minutes)
Los Angeles to San Francisco/Oakland	2:42	2:30
Los Angeles to Sacramento	2:22	2:10
Los Angeles to San Jose	2:12	2:00
San Francisco / Oakland to San Jose	0:30	0:30
Los Angeles to San Diego	1:00	1:00
Fresno to Sacramento	0:55	0:55
Fresno to San Jose	0:45	0:45
Fresno to Los Angeles	1:32	1:20
Bakersfield to Los Angeles	0:62	0:50
Bakersfield to Sacramento	1:25	1:25
Bakersfield to San Jose	1:20	1:20
Santa Clarita[1] to San Jose	1:57	1:45
Santa Clarita[1] to Sacramento	2:02	1:50
Santa Clarita[1] to Fresno	1:12	1:00

Note:
[1] The location of the Santa Clarita station varies by alternative.

3.0 ALIGNMENT/STATION DEFINITION

Each Regional Team will be identifying and developing a number of alignment and station options to be considered in this screening evaluation, based on a review of previous corridor evaluation studies and a review of current regional conditions, both institutional and physical. These alternatives need to be defined and developed consistently with previous studies and systemwide consideration and goals. This chapter presents the engineering and operating parameters and assumptions that should be used to develop all of the alignment and station options to be considered. The Regional Team must document the screening process and provide input for the administrative record to the Program Management Team. Unique features or constraints should be identified that may require modifications to the established assumptions and parameters. These issues will be addressed by the Program Management Team and coordinated with the other Regional Teams for consistency.

3.1 SYSTEM PARAMETERS

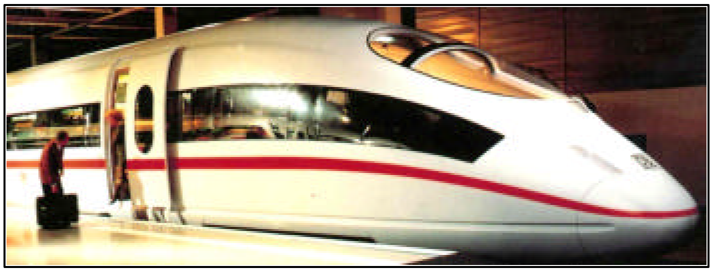
3.1.1 Technology

The design, cost and performance parameters defined in this document are based on two technology groups. The groups are classified by their speed (both currently obtainable speeds as well as targeted speeds that may result from further research and development) and by similar design characteristics.

The Very High Speed (VHS) group includes trains capable of maximum operating speeds near 220 mph (350 km/h) utilizing steel-wheel-on-rail technology (Figure 3.1.1). To operate at high speeds, a dedicated, fully grade-separated right-of-way is necessary with more stringent alignment requirements than those needed for lower speed lines. However, it is possible to integrate VHS systems into existing conventional rail lines in the congested urban areas given resolution of certain equipment and operating compatibility issues. All VHS systems in operation use electric propulsion with overhead catenary and include the Train à Grande Vitesse (TGV) in France operating at 186 mph (300 km/h) and the InterCity Express (ICE) in Germany, which operates at 155 mph (250 km/h).

The magnetic levitation (maglev) group utilizes either attractive or repulsive magnetic forces to lift and propel the train along a guideway (Figure 3.1-1). Current systems under development are designed for maximum operating speeds above that of VHS technology. The Federal Railroad Administration's (FRA's) Maglev Deployment Plan is currently considering maximum operating speeds of 240 mph (385 km/h) for the implementation of a maglev demonstration project in this country. Magnetic levitation allows the vehicles to hover or "float" a small distance above the guideway, thereby eliminating friction and rolling resistance. Due to the unique, dedicated guideway required, the shared use of track by conventional steel wheel systems is not possible although right-of-way may be shared.

Figure 3.1-1
VHS and Maglev Technology



VHS Train (ICE)

Maglev (Transrapid)

3.1.2 Shared Use/Compatibility Issues

The technology choice will affect the type of service integration permitted by the new network. The use of maglev technology creates a unique system of infrastructure and passenger carrying equipment. Existing conventional railroad equipment cannot use this infrastructure so efforts to develop seamless transportation opportunities would concentrate on convenient and easy intermodal transfer designs to effectuate a smooth transfer of passengers from one mode to another.

Using a steel-wheel, steel-rail technology (VHS) may seem to be more easily integrated with conventional passenger and even freight railroad services; however, current FRA requirements for rolling stock used in mixed traffic preclude shared use of trackage by conventional railroad equipment and available very high-speed equipment. On European and Asian railroads, conventional railroad traffic in the congested areas near major cities also share the right-of-way with high-speed trains. Because of the heavy constraints on right-of-way in the urban areas, it is important that this study consider the potential for integration of steel-wheel, steel rail (VHS) high-speed services on conventional passenger rail lines, in addition to convenient and easy transfer designs between modes.

The key issue for design of an integrated passenger rail system that includes high-speed segments is the impact that these FRA requirements have on the "mixing of traffic". In this case "mixed traffic," means that conventional passenger equipment, high-speed equipment and freight railroad equipment would be operated on the same set of railroad tracks. Mixed traffic is not a new concept if a steel-wheel, steel-rail technology is chosen. Mixed freight and conventional passenger trains are operating everyday throughout the United States on the same railroad segments. On the four-track Northeast Corridor main line for instance, Amtrak Metroliners, slower Northeast Direct trains, local and regional commuter trains and freight trains are routinely operated on the same rail rights-of-way with different track assignments.

The issue becomes complicated, however, when the equipment to be operated on the same segments is constructed to different structural design standards. One key FRA requirement is the actual "buff strength" of railroad rolling stock. This is the amount of force that can be applied to the end of a trainset (passenger cars and locomotives or power units) without causing the cars or locomotives to crumple. A high buff strength requirement (a "crash-worthiness" standard) protects the passengers and railroad employees inside the train in the event of a collision.

In Europe and Asia, where high-speed rail operates with an excellent safety record, rolling stock is manufactured to different tolerances than required for rolling stock operated on United States railroads regulated by the FRA. These European and Asian passenger and freight trains have been designed for power, speed, and safety, but their safety standards focus on accident avoidance, rather than accident survival. These lighter trains do not meet FRA buff strength requirements.

The possibility of operating the proposed ~~HSR~~high-speed train system with some segments of mixed traffic could significantly affect right-of-way and infrastructure costs on the California high-speed rail project, particularly as the line penetrates dense urban areas such as the Bay Area in Northern California and the Los Angeles basin in Southern California. If mixed traffic options could be considered, it would permit alignment and design options that would be less costly than the construction of new separated rights-of-way to enter urban areas. If mixed traffic options are not permitted, high-speed infrastructure must be separated and constructed to reach the proposed terminal sites.

It is clear that both options must be considered in the program environmental document and shared use options in particular, must be addressed in urban corridors, as applicable in this screening evaluation. The implementation of shared use in the California system may encompass a variety of solutions including changes to the design and manufacture of ~~HSR~~high-speed train equipment; changes in the type of conventional passenger and freight equipment used on the potential shared use corridors; changes in the current operating (train control, signaling, etc.) practices; and changes in the regulatory requirements. Whatever the means, shared use options should be defined for this screening that will address the potential for ~~HSR~~high-speed train equipment to share corridors and tracks with existing services. This will be accomplished by assuming that certain strategies could be implemented to allow shared use and by then defining the physical extent of the infrastructure and right-of-way required to accommodate the optimal mix.

3.1.3 Potential Freight Services

In addition to the compatibility issues described above, there are other issues associated with the potential operation of freight services with ~~HSR~~high-speed train passenger services. Operating freight trains at axle loads approaching conventional U.S. axle loads would compromise ~~HSR~~high-speed train operating efficiency, maintenance standards/tolerances and strict safety requirements. Conventional U.S. freight trains also require different track geometry in terms of superelevation. In addition to the substantially higher axle loads required by the conventional railroad freight services, larger clearances due to the size of the double or piggyback cargo containers are also required. These larger clearances would impact the design of the electrification distribution system, undercrossings and tunnels. For these reasons operation of conventional full-tonnage freight trains ~~is~~ would be incompatible with a ~~HSR~~high-speed train system in California.

Two other types of freight movement ~~are~~ would be compatible with California ~~HSR~~ high-speed trains and would provide significant growing markets.

SMALL PACKAGE/LIGHT CONTAINER

Package/container versions of the high-speed passenger vehicles (both VHS and maglev) can be adapted, without compromising operating capabilities, to handle mail, express parcel, package freight, and other container freight that does not exceed the weight of typical passenger loads. Examples of this type of freight include overnight small packages and mail, distributed by such entities as Federal Express, United Parcel Service, and the U.S. Postal Service. The equipment used for these services must be completely compatible with the passenger equipment and be capable of safely traveling at the top design speeds of the entire high-speed system.

SPECIAL MEDIUM-WEIGHT FREIGHT

These high speed (VHS technology) medium weight freight trains would have limited axle loads of about 19 metric tons[1] or less, as opposed to conventional full-tonnage U.S. freight of about 27 metric tons per axle. These freight-only trains would be designed to meet high-speed system safety and design standards but would only operate during nighttime hours, at no more than 125 mph (200 km/h). The freight-only periods would be scheduled after passenger trains were beyond the area of freight operations and would be coordinated so as not to interfere with required nighttime maintenance activities. These maintenance services could be provided on the system currently being proposed within the established parameters of cost and design. As currently planned, maglev freight trains could carry up to 18 metric tons per car on the guideway.[2] The maglev freight trains with up to 20 cars could be operated at speeds up to 125 mph (200 km/h). By restricting these high-speed freight operations to the non-passenger service hours (night time), conflicts with the faster ~~HSR~~ high-speed passenger trains can be avoided.

FREIGHT INFRASTRUCTURE

Freight services on the high-speed network will require operating arrangements and physical facilities to handle freight at both origin and destination points.

For small package and light container services, loading and unloading can be accomplished quickly at passenger stations. Employees would unload and load any material destined for each station quickly within the dwell times established for passenger trains. This will require interior designs that permit sorting "on the go" and fast means of accepting new packages and releasing packages from the car to the platform. Special destination specific containers may be part of the overall design for this type of service. For these types of freight, accommodations will be required at stations for package deliveries, and for assembly into destination-specific containers and disassembly for final delivery.

For heavier freight services, which will be handled by special "freight only" trains, infrastructure requirements may be more elaborate. If these trains are handled during "freight only" operating windows when no passenger trains are on the network, passenger stations could be used to handle goods. It may be necessary to build special loading and unloading facilities either adjacent to the passenger platforms or at remote sites. These issues are freight service design issues, which need to be incorporated into whatever processes the Authority chooses, to advance the freight concepts toward business planning. The Authority has adopted the policy of excluding the cost of any special freight equipment or infrastructure as part of the initial financial and operating plans.

Since the Authority's proposal is focused on passenger service, specific freight operating plans and infrastructure will not be addressed as part of this screening evaluation. However, the engineering parameters established by the Authority allow for future implementation of freight services as the market dictates.

3.2 ENGINEERING PARAMETERS

This section presents the design parameters including speeds, geometry and clearances to be applied in the screening evaluation for each of the candidate technologies. The criteria presented are consistent with the criteria applied in the previous corridor evaluation study and are based on accepted engineering practice, the criteria and experiences of other railway and high-speed rail systems, and recommendations of VHS and maglev manufacturers. The alignment criteria and clearances, as set forth, were established with the following objectives:

[1] One metric ton equals 1.102 English tons.

[2] Per Transrapid International, Maglev freight trains can carry up to 30 metric tons per car if special guideway sections are used.

- Maximum system safety
- Acceptable passenger comfort
- Minimum wear on rails and wheels for rail technologies
- Compatibility with railcar characteristics
- Maximum operating speed and efficiency.

The main engineering design parameters and criteria are summarized in Table 3.2-1 and described below.

Table 3.2-1
Summary of Engineering Design Parameters

Parameter	Very High-Speed	Maglev
Double Track	Full	Full
Power Source	Electric	Electric
Grade Separations	Full	Full
Potential for Shared Use	Yes	No
Corridor Width ❑ **Desirable** ❑ **Minimum**	 100 ft (30.4 m) 50 ft (15.2 m)	 100 ft (30.4 m) 50 ft (15.2 m)
Top Speed	220 mph (350 km/h)	240 mph[1] (385 km/h)
Average Speed	125-155 mph (200-250 km/h)	145-175 mph (230-280 km/h)
Acceleration	0.4-1.3 mph/s[3] (0.6-2.1 km/h/s[4])	1.1-1.9 mph/s (1.8-3.2 km/h/s)
Deceleration	1.2 mph/s (1.9 km/h/s)	1.8 mph/s (2.9 km/h/s)
Minimum Horizontal Radius	500-650 ft (150-200 m)	1,150 ft (350 m) (2)
Minimum Horizontal Radius (at top speed)	15,600 ft @ 220 mph (4,750 m @ 350 km/h)	11,500 ft @ 240 mph (3,500 m @ 385 km/h)
Superelevation ❑ **Actual (Ea)** ❑ **Unbalanced (Eu)**	 7 in (180 mm) 5 in (125 mm)	 16° 5°
Grades ❑ **Desirable Maximum** ❑ **Absolute Maximum**	 3.5% 5.0%	 NA 10.0%
Minimum Vertical Radius Crest Curve (at top speed)	157,500 ft @ 220 mph (48,000 m @ 350 km/h)	205,700 ft @ 240 mph (62,700 m @ 385 km/h)
Minimum Vertical Radius Sag Curve (at top speed)	105,000 ft @ 220 mph (32,000 m @ 350 km/h)	137,100 ft @ 240 mph (41,800 m @ 385 km/h)
Horizontal Clearance (centerline of track to face of fixed object)	10 ft 4 in @ 220 mph (3.1 m @ 350 km/h)	9 ft 5 in @ 240 mph (2.8 m @ 385 km/h)
Vertical Clearance (top of rail to face of fixed object)	21 ft (6.4 m)	12 ft 2 in (3.7 m)
Track Centerline Spacing	15 ft 8 in @ 220 mph (4.7 m @ 350 km/h)	15 ft 9 in @ 240 mph (4.8 m @ 385 km/h)

Notes: 1- Top Speed Defined in Federal Maglev Deployment Plan
2- Transrapid USA, 1998.
3- mph/s – miles per hour-second
4- km/h/s – kilometers per hour-second

3.2.1 Speeds

The proposed technology is focused on the next generation of VHS and maglev trains to provide both frequent service and fast travel times. It is anticipated that trains will travel at maximum operating speeds near 220 mph (350 km/h) for VHS technology and 240 mph (385 km/h) for maglev. Average operating speeds will of course, be lower, around 155 mph (250 km/h) for VHS technology and 185 mph (300 km/h) for maglev. Speeds in urban areas are constrained to a maximum of approximately 125 mph (200 km/h) for either technology due to physical (curve radius) and environmental constraints (visual or noise/vibration). These speeds allow for express travel times consistent with the travel time goals set forth in Chapter 2.0.

Existing ~~HSR~~high-speed train systems in Europe and Japan currently operate at speeds of 187 mph (300 km/h) and suggest that speeds of 220 mph (350 km/h) are or will be obtainable within the implementation period of the California system. All of the system operators agree that there are significant obstacles to implementing the higher speeds. Specifically, the higher speeds are associated with increased maintenance of infrastructure and vehicles, higher maintenance costs, higher noise levels and higher energy usage and costs. Decisions have been made in Germany to limit the maximum operating and design speeds to 187-200 mph (300-320 km/h) due to the economic viability of the increased maintenance and energy usage costs. France is currently testing higher operating speeds of mph (320 km/h) and currently designs new lines for potential operation at 220 mph (350 km/h). Japan does not plan to increase speeds beyond 187 mph (300 km/h), due to existing infrastructure limitations and strict environmental requirements concerning noise.

Given the technical viability of 220 mph (350 km/h) ~~HSR~~high-speed train operating speeds and the strong advantages of lower travel times on California's long intercity markets, it is prudent to continue to accommodate these speeds in the design and development of the alignments considered for this system.

Table 3.2-2 presents the range of maximum operational speeds and acceleration/deceleration characteristics assumed for the two technology groups under consideration, allowing for expanded capabilities in the next generation of VHS equipment. Because of variations in performance and equipment characteristics, each group has its own geometric design criteria.

Table 3.2-2
Design Speeds

	VHS (Steel Wheel)	Maglev
Top Speed	220 mph (350 km/h)	240 mph (385 km/h)
Average Speed	125 – 155 mph (200 – 250 km/h)	145 – 175 mph (230 – 280 km/h)
Acceleration 0 – 62 mph 62 – 124 mph 124 – 186 mph 186 + mph	mph/s[1] (km/h/s[2]) 1.3 2.1 1.0 1.6 0.6 1.0 0.4 0.6	mph/s (km/h/s) 1.9 3.2 1.9 3.2 1.5 2.5 1.1 1.8
Deceleration	mph/s (km/h/s) 1.2 1.9	mph/s (km/h/s) 1.8 2.9
Note: 1- mph/s – miles/hour-second 2- km/h/s – kilometers/hour-second		

3.2.2 Electrification

An electrical propulsion system is necessary to provide the performance characteristics (e.g. speed and acceleration) required to be competitive with other modes of travel in California. Both of the above technology types utilize electric propulsion systems.

3.2.3 Double Track/Guideway

Both technology types require a dual track/guideway system to safely support the ridership volumes, frequency of service, scheduling flexibility and delay recovery required for this California corridor.

3.2.4 Grade Separation

Due to the safety and performance requirements, there will be no grade crossings permitted on the dedicated ~~HSR~~high-speed train lines. No unauthorized vehicles or pedestrians will be permitted to enter the corridor or cross the tracks at grade, which would expose them to a possible collision with a train. In addition, the right-of-way will be fully access controlled (fenced) in areas of high-speed operation to avoid intrusion by pedestrians, wildlife and livestock. This requirement applies to both the dedicated and shared use operation alternatives.

3.2.5 Horizontal Alignment

The horizontal alignment design parameters are based on passenger comfort; limiting the lateral force on the passenger. To limit the discomfort caused by excessive lateral force, the track is superelevated (tilted) toward the inside of the curves. Minimum lengths of tangents and curves are required for VHS, and spiral transition curves are applied to assure a gradual introduction of lateral force. The steady state lateral forces are limited to 0.1g or 3.2 ft/s^2 (1 m/s^2) in the design parameters described below for both technology groups. Table 3.2-3 includes formulae for determining superelevation and minimum lengths of tangents, curves, and transition curves for the two technology groups.

Table 3.2-3
Horizontal Alignment Criteria

	VHS	Maglev
Minimum tangent length (Lt)	2.22 V (>500')	not required
Equilibrium superelevation (Ee)	$\frac{4.01 V^2}{R}$	$\sin^{-1}\left(\frac{V^2}{14.95R}\right)$
Unbalance superelevation (Eu)	Ee-Ea	Ee-Ea
Max Ea	7 "	16°
Max Eu	5 "	5°
Minimum length of circular curve (Lc)	2.22 V	2.22 V
Minimum radius (absolute @ minimum speed)	650 ft (200 m)	1,148 ft (350 m)
Spiral length (Le) (greater of) none required if Ls<0.01 R	l.38 Ea V 0.98 Eu V 62 Ee	1.47 Ea V 56.05 V sin Eu 66 Ee

Notes: **Ea** = actual superelevation (inches or degrees), **Ee** = equilibrium superelevation (inches or degrees), **Eu** = unbalanced superelevation (inches or degrees), **Lc** = minimum length of circular curve (feet), **Le** = spiral length (feet), **Ls** = minimum length of transition spiral (feet), **Lt** = minimum tangent length (feet), **R** = radius (feet), **V** = velocity (mph)

3.2.6 Vertical Alignment

The vertical alignment, also known as the profile, traces the elevation of the top of rail or top of the maglev guideway running surface. Maximum profile gradients are based on trainset performance. The length of vertical curves is governed by the vertical force that passengers can comfortably experience in profile crests and sags. According to standard U.S. passenger rail practices, the allowable forces in sags (downward 0.03g) is slightly greater than that for crests (upward 0.02g) and are practically the same from a standpoint of minimum and desirable criteria. There is also a minimum length of profile tangent and vertical curves, which prevent a roller coaster effect in profiles.

Table 3.2-4 lists recommended maximum gradients for main lines, secondary tracks and yards, and stations. Also included are formulae for computing radii of vertical curves and minimum curve and tangent lengths.

Table 3.2-4
Vertical Alignment

	VHS	Maglev
Length of constant grade (Lt)		
Desirable	4.38 V	not required
Minimum	2.22 V (<500')	not required
Gradient (in %)		
Mainline Tracks:		
(desirable maximum)	3.5	not required
(absolute maximum)	5.0	10.0 (1)
Station Tracks: (desirable minimum)	0.0	0.0
(absolute maximum)	0.25	0.25
Yards and secondary tracks:	0.0	0.0
Storage and transfer tracks:	0.0	0.0
Vertical curve radius (R)		(2)
Crest	$3.33\ V^2$	
Sag	$2.22\ V^2$	
Length of vertical curve (LVC)		(2)
Desirable	4.38 V	
Minimum	2.22 V	
(increase 50% if in horizontal curve)		

Notes:
Lt = length of constant grade (feet), **LVC** = length of vertical curve (feet), **R** = vertical curve radius (feet), **V** = velocity (mph)
(1) Combined effects of steep grades and horizontal curves on passenger comfort will need to be considered in design phase of project.
(2) More information has been requested from Transrapid International regarding geometric formulae. Use VHS criteria for Maglev alignment development in this screening evaluation.

3.2.7 Clearance Requirements

Adequate clearances assure the safe passage of trains, access to disabled trains, and safe conditions for maintenance personnel and passenger evacuation. Minimum clearances are listed below in Table 3.2-5.

3.2.8 Right-of-Way Requirements

The minimum right-of-way limits for typical operating sections of the ~~HSR~~high-speed train system are shown in Table 3.2-6. These limits represent the minimum right-of-way required for basic implementation of a specific operating section. Other factors such as topography, soils, groundwater levels, noise receptors, cut-and-fill slopes, drainage, retaining walls, service roads, utilities, technology

(VHS or maglev) operating speeds, and construction methods also influence the extent of the required right-of-way envelope. Typical cross-sections for each technology group are included in Appendix A.

Table 3.2-5
Clearances

	VHS	Maglev[(1)]
Horizontal		
Centerline of Track/Guideway to Face of Fixed Object	10 ft 4 in (3.1 m) @ 220 mph (350 km/h)	9 ft 5 in (2.85 m) @ 240 mph (385 km/h)
Vertical		
Top of Rail/Guideway to Face of Fixed Object (minimum)	21 ft (6.4 m)	12 ft 2 in (3.7 m)
Minimum for shared operation	26 ft (7.9m)	N.A.
Track/Guideway Centerline Spacing		
Double Track Center to Center Distance	15 ft 8 in (4.7 m) @ 220 mph (350 km/h)[(2)]	14 ft 5 in (4.4 m) @ 240 mph (385 km/h)
Emergency Walkway Width		
Minimum Clear	30 in (76.2 cm)	30 in (76.2 cm)

Notes: 1-Transrapid Maglev.
2-TGV system requires 4.5 m, ICE requires 4.7m @ 350 km/h.

Table 3.2-6
Minimum Right-of-Way Requirements

Type of Section	VHS	Maglev
At-Grade/Cut-and-Fill/Retained Fill	50 ft (15.2 m)	47 ft (14.3 m)
Aerial Structure	50 ft (15.2 m)	49 ft (15 m)
Tunnel (Double Track)	67 ft (20.4 m)	67 ft (20.4 m)
Tunnel (Twin Single Track)	120 ft (36.6 m)	120 ft (36.6 m)
Trench/Box Section	70 ft (21.3 m)	73 ft (22.2 m)

For the purposes of this screening evaluation, three general parameters should be followed: (1) a minimum right-of-way corridor of 50 feet (15.2 meters) should be assumed in congested corridors; (2) a 100-foot (30.4-meter) corridor should be assumed in less developed areas to allow for drainage, future expansion and maintenance needs; and (3) a wider corridor should be assumed in variable terrain to allow for cut and fill slopes and twin-bore tunnel. In these wider sections corridor width should be determined according to the minimum requirements stated in the Table 3.2-6 above, and the general assumption of 2:1 cut and fill slopes. Other corridor widths should be applied when identifying potential environmental impacts as defined in Section 4.3.

3.2.9 Stations

Several key factors must be considered in the identification of potential station stops along the system, including ability to maintain approach and through service speed; cost; ridership potential; operating policy; local access times; intermodal connectivity; and the distribution of population and major destinations along the route. All intermediate stations incorporate siding tracks for stopping trains, allowing through movement of express trains. This assumption directly addresses speed and operating issues. In general, stations are spaced following the pattern of urban centers (about 50 miles apart in rural areas), with overall average spacing at approximately 30 miles and in metropolitan areas an average spacing of 15 miles. Closer spacing would have significant impacts on the ability to operate express and local traffic on the same dual track system in these areas due to substantial differences in operating speeds.

STATION DESIGN/SIZING PARAMETERS

There are two principal types of stations: terminus and intermediate. Terminus stations are those where all trains are planned to stop and perhaps lay-over during non-peak periods. San Diego, Los Angeles Union Station, LAX, San Francisco, Oakland, and Sacramento are all planned as terminus stations. All other potential stations are intermediate stations. Intermediate stations will provide off-line passenger platforms allowing for pass-through express services on the dual track mainline. Each Regional Team is responsible for proposing station configurations that best meet the criteria defined herein for any shared use options considered in their region. Table 3.2-7 illustrates the forecasted daily boardings for each station in the year 2040, based on Sensitivity Analysis Scenario 6B by Charles River Associates. This scenario represents the assumed conditions for the purposes of the environmental process.

STATION PLATFORMS

The typical configuration for intermediate stations in dedicated ~~HSR~~high-speed train service is defined below in Table 3.2-8. The preferred layout includes information on turnouts and crossovers that are currently being used on ~~HSR~~high-speed train systems. New turnout and crossover designs suited for even higher speeds are currently being researched and the preferred layout will include these when the data becomes available.

Based on the conceptual service plan prepared in the previous Corridor Evaluation Study, all intermediate stations should assume a minimum arrangement of two off-line platforms as shown in Table 3.3-8. Terminal stations will need to be addressed on an individual basis due to the variety of conditions and needs at each terminal of the proposed system. The stations will likely have high-level boarding platforms to facilitate loading and unloading of passengers as well as to meet requirements for disabled passengers per the Americans with Disabilities Act (ADA). Most of the potential equipment vendors only manufacture high platform ~~HSR~~high-speed train vehicles. However, at least one potential equipment vendor offers low platform capability. Station platforms are assumed to have a minimum length equivalent to that of a two multi-car trains, approximately 1,300 feet (400 meters). This platform length allows for flexibility in operations by allowing for variation in trainset composition and potential temporary storage at station platforms. Station platforms are assumed to have a width of 30 feet (9 meters), inclusive of vertical access, for the purposes of this screening evaluation. Some flexibility with these dimensions may be required at terminal locations and will be considered on an individual basis. Ridership forecasts will be analyzed to define more specific platform widths during the subsequent more detailed analysis.

The platform dimensions listed above are "preferred" values that Regional Teams should strive to achieve for each station option. However, options should not be screened out based solely on their ability to meet these guidelines. We will consider these factors in the next stage of technical analysis, when the implications of not achieving these dimensions can be more thoroughly evaluated.

Table 3.2-7
Forecasted Daily Boardings

Station Name	Average Daily Boardings[1]
Sacramento	14,752
Stockton - Downtown	1,880
Stockton - Suburban Manteca	1,880
San Francisco	21,523
San Francisco Airport	2,885
Redwood City	6,253
San Jose	12,094
Gilroy	2,752
Los Banos	193
Modesto - Downtown	1,685
Modesto - Suburban Briggsmore	1,685
Merced - Downtown	514
Merced - Suburban	514
Fresno - Downtown	3,546
Fresno - Suburban	3,546
Tulare/Kings-Visalia or Hanford	158
Bakersfield - Downtown	2,674
Bakersfield - Suburban Fruitvale	2,674
Santa Clarita	4,395
Burbank Airport	6,653
Los Angeles Union Station	18,738
East San Gabriel Valley	12,772
Ontario Airport	2,635
Riverside	4,875
Temecula	2,481
Escondido	3,349
Mira Mesa	1,675
Qualcomm Stadium	13,311
Oakland Airport	596
Oakland	10,200
Fremont/Newark	2,705
Palmdale Airport	2,008
LAX Airport	Not Available
Norwalk	3,621
Anaheim	6,876
Irvine	3,085
Oceanside	4,876
University Town Center	4,975

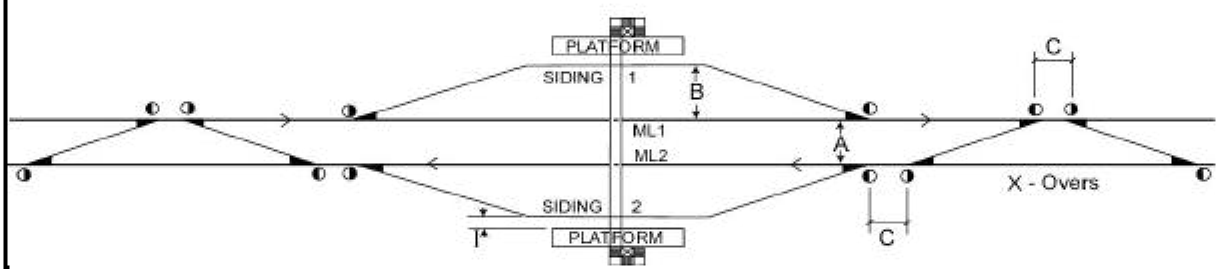
Notes: 1- Year 2040 Forecast, Sensitivity Analysis Scenario 6B by Charles River Associates, 1999.

Table 3.2-8
Intermediate Station Concept

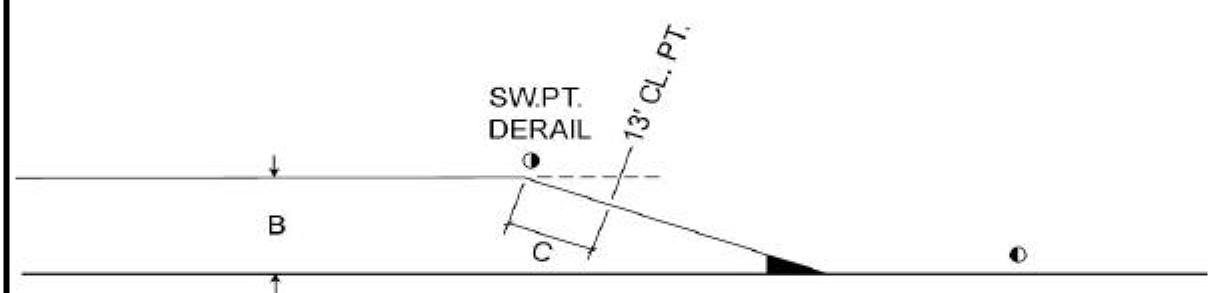
	A	B	C	D	E	F*	G	H	I
	PREFERRED								
Feet	20	25	328	Varies	833	6000	1312	22	5
(Meters)	6.1	7.6	100.0	Varies	253.9	1828.8	400.0	6.7	1.5

Based upon No. 32.7 T.O. : Point "E" = 13' Cl.Pt.
* Includes Minimum safety stopping margin for 80 MPH (130 km/h)

PREFERRED ARRANGEMENT



TURNOUT DETAIL



3.3 Operating Assumptions and Parameters

This section describes the overall strategy and conceptual service parameters assumed for the potential ~~HSR~~high-speed train service in California. A conceptual service plan was developed as part of the previous corridor evaluation and should be used for evaluating the alignment and station options. This operating strategy should be used as a general basis for the comparison of estimation of operation and maintenance costs. Specific scheduling and operations modeling analysis is currently underway and will be provided for detailed engineering and environmental analysis of the final set of alignment and station options in the next phase of this study. Further iterations, testing the operating assumptions with demand forecasting models, may also be required.

3.3.1 Conceptual Operating/Service Plan

In the previous study a conceptual operating/service plan was developed in conjunction with high-speed rail ridership forecasts, reflecting service requirements in the San Diego, Los Angeles, San Francisco Bay Area, and Sacramento corridors. As preliminary ridership forecasts were refined, the operating plan was adjusted to achieve a more appropriate level of service – this was an iterative process between the ridership plan and the corridor evaluation studies. The operating plan assumes trains with a capacity of 600 to 650 passengers operating with at least a 65 percent occupancy rate. These assumptions should be applied in the comparison of alignment and station options.

The basic service pattern would be between 6:00 a.m. and 8:00 p.m. for most trains between Los Angeles to San Francisco, with some trains starting or finishing trips beyond these hours. To augment the basic service, trains are added in the peak periods, and some trains in the basic pattern make extra stops. Extra express and suburban-express trains are inserted into gaps in the basic schedule during the peaks. The extra suburban-express stops are made to serve residents of suburban communities who have a destination at the far end of the route. In the evening, some of the express trains destined for Los Angeles also stop in the suburban Los Angeles area to deposit such a rider close to home. A similar pattern of extra stops occurs on the north end of the route around San Francisco.

For statewide intercity service, sixty-four weekday trains in each direction were assumed in the conceptual operating scenario based on Year 2020 forecasts. The intercity trains are comprised of four service categories:

- <u>Express (20 trains/day)</u> - Trains running from either Sacramento, San Jose or San Francisco to Los Angeles and San Diego without intermediate stops.
- <u>Semi-Express (12 trains/day)</u> - Trains running between similar endpoints as the express, with intermediate stops at major Central Valley cities such as Modesto, Fresno and Bakersfield.
- <u>Suburban-Express (20 trains/day)</u> - Trains running "local " during either the beginning or the end (LA or Bay Area) of the trip while running express through the intermediate points.
- <u>Local (12 trains/day)</u> - Trains stopping at all intermediate stops with potential for skipping stops to improve service, depending on demand.

For regional service, twenty-two weekday trains in each direction were assumed in two service categories:

- <u>Semi-Express (8 trains/day)</u> - Trains running from either Sacramento and San Francisco or Los Angeles and San Diego to stations in the middle of the corridor, such as Fresno or Bakersfield. Also, trains running between northern termini (Sacramento and San Francisco). These trains would make limited stops at intermediate stations.
- <u>Local (14 trains/day)</u> - Trains stopping at all intermediate stops on regional routes with potential for skipping stops to improve service to stations with highest demand.

The level of service estimates for each main segment of the system are illustrated in Figure 3.3-1. The conceptual service plan, which was developed to account for a variety of routing combinations and technologies, provides estimated total daily station stops as shown in Table 3.3-1.

Figure 3.3-1
Daily Service Level Estimates

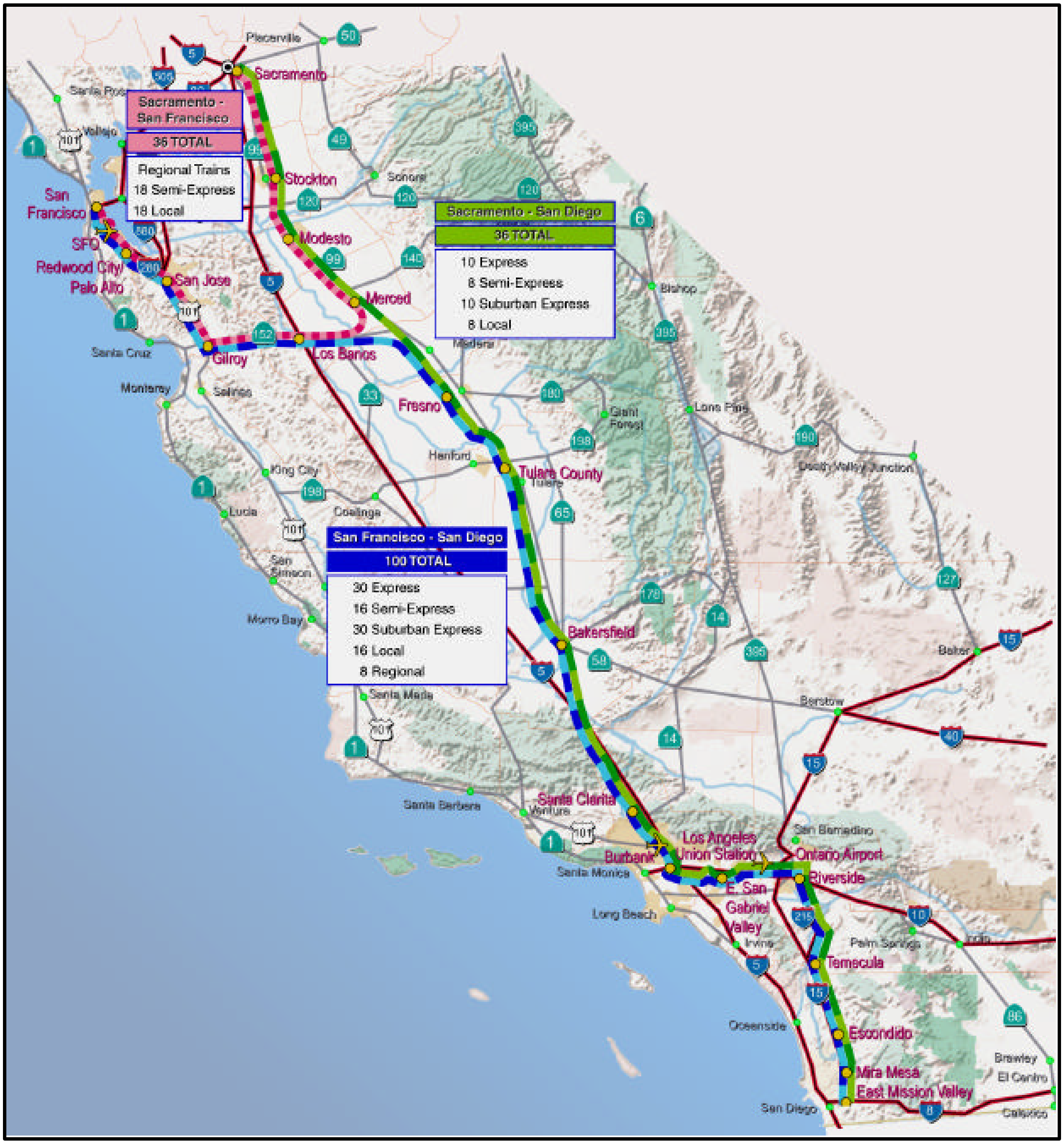


Table 3.3-1
Total Daily Station Stops

	Stations											
	San Diego	**Mira Mesa**	**Escondido**	**Temecula**	**Riverside**	**Ontario**	**East San Gabriel**	**Los Angeles**	**Burbank**	**Santa Clarita**	**Palmdale**	**Bakersfield**
Intercity	92	64	64	64	64	64	64	128	64	64	64	72
Regional	4	4	4	4	4	4	4	4	4	4	4	4
Total	**96**	**68**	**68**	**68**	**68**	**68**	**68**	**132**	**68**	**68**	**68**	**76**
	Stations											
	Tulare	**Fresno**	**Los Banos**	**Gilroy**	**San Jose**	**Redwood City**	**San Francisco Airport**	**San Francisco**	**Merced**	**Modesto**	**Stockton**	**Sacramento**
Intercity	24	48	16	46	66	28	28	62	8	16	26	36
Regional	0	4	14	14	28	14	14	40	10	10	10	36
Total	**24**	**52**	**30**	**60**	**94**	**42**	**42**	**102**	**18**	**26**	**36**	**72**

Note: Total daily station stops (both directions) for intercity and regional services estimated according to the conceptual service plan as defined in the Corridor Evaluation Final Report, 1999.

3.3.2 Capacity

Capacity is expressed in terms of spacing trains along the guideway in order to provide for safe stopping of a following train if a train slows down or stops. The space between trains is the headway. A three-minute headway means at the dispatch points trains can originate three-minutes apart. Along the line, a three-minute headway means that at track speed (the speed permitted on the section of track) trains can be safely spaced four minutes apart. At intermediate stations, where additional tracks are available to permit trains to pass the station, a train can be dispatched almost immediately after another train has passed the station since its acceleration to the main track provides the time to maintain the four-minute spacing.

4.0 ALIGNMENT/STATION SCREENING EVALUATION

As part of previous studies, a number of alignment options and general station locations were studied and evaluated. Many of the options considered were deemed non-viable or significantly inferior to other options considered, due to their individual physical and environmental constraints, performance, cost and potential impacts. A number of specific alignment and station location options remain within the generally defined corridors described in the previous chapter. These options, as well as other options which arise during the screening process, will need to be evaluated at a planning level and screened to identify the most viable options for more detailed study as part of the Program EIR/EIS. This screening evaluation will be based on key objectives of the system and is consistent with the design parameters and evaluation criteria applied in the previous Corridor Evaluation completed in December 1999.

4.1 EVALUATION OBJECTIVES AND CRITERIA

A number of key objectives and criteria have been established for application to this alignment and station screening evaluation. While the objectives and criteria listed in Table 4.1-1 are primarily based on previous corridor evaluation studies for the purposes of consistency, they have been enhanced to reflect the performance goals and criteria described in Chapter 2.0, as established by the Authority for this project. The objectives and criteria are divided into two main categories of engineering and environmental as summarized in the table below and described in the following sections.

Table 4.1-1
High-Speed Rail Alignment/Station Evaluation Objectives and Criteria

Objective	Criteria
Maximize Ridership/Revenue Potential	▪ Travel Time ▪ Length ▪ Population/Employment Catchment
Maximize Connectivity and Accessibility	▪ Intermodal Connections
Minimize Operating and Capital Costs	▪ Length ▪ Operational Issues ▪ Construction Issues ▪ Capital Cost ▪ Right-of-Way Issues/Cost
Maximize Compatibility with Existing and Planned Development	▪ Land Use Compatibility and Conflicts ▪ Visual Quality Impacts
Minimize Impacts to Natural Resources	▪ Water Resources ▪ Floodplain Impacts ▪ Threatened & Endangered Species Impacts
Minimize Impacts to Social and Economic Resources	▪ Environmental Justice Impacts (Demographics) ▪ Farmland Impacts
Minimize Impacts to Cultural Resources	▪ Cultural Resources Impacts ▪ Parks & Recreation/Wildlife Refuge Impacts
Maximize Avoidance of Areas with Geologic and Soils Constraints	▪ Soils/Slope Constraints ▪ Seismic Constraints
Maximize Avoidance of Areas with Potential Hazardous Materials	▪ Hazardous Materials/Waste Constraints
Minimize Public, Political, and Institutional Conflicts	▪ Public/Political/Institutional Issues

4.2 ENGINEERING EVALUATION CRITERIA

The engineering evaluation criteria focus on cost and travel time as primary indicators of engineering viability and ridership potential. For instance, if capital costs are appropriately estimated addressing a comprehensive list of cost elements, the cost estimates will reflect the level of physical constraints and construction difficulty associated with a particular alignment or station option as well as the general viability of that option. Likewise, estimated travel times indicate the differences in potential ridership, when compared among various alignment and station options.

Items such as capital, operating and maintenance costs and travel times can be quantified for each of the alignment and station options considered. Methods and assumptions for measurement and evaluation of these criteria are described in this section.

Other engineering criteria such as operational, construction and right of way issues need to be identified and presented in a qualitative manner for each of the options to provide context for the evaluation. Any condition that poses a significant constraint or opportunity for the operation and/or construction of a ~~HSR~~high-speed train system should be identified and described for each alignment and station option.

4.2.1 Ridership/Revenue Potential

The development of ridership and revenue forecasts for each of the alignment and station options is beyond the scope and timeframe of this screening evaluation. Two items will be measured to indicate the relative ridership and revenue potential of each alignment and station options. Travel time will be estimated to indicate the relative attractiveness of alignment options. The population and employment within the reasonable catchment area will be quantified in indicate the potential ridership of each station option.

A. TRAVEL TIME ESTIMATING

Travel times should be estimated for each of the alignment options based on alignment geometry, top speed assumptions and general train performance characteristics. Specifically, the travel time estimates should account for acceleration and deceleration capabilities of each technology and the ability of each technology to maintain passenger comfort criteria through horizontal and vertical curves. Speed degradation on sustained vertical grades has been estimated based on simulations to verify and validate the results of the travel times estimated in previous corridor evaluation studies. Travel time estimating worksheets have been developed by the Program Manager as part of previous studies and will be provided for application in this screening evaluation. The travel time worksheets contain top speed assumptions and acceleration/deceleration rates and formulas. An example travel time worksheet is shown below in Table 4.2-1. Travel time worksheet files are included in Appendix B for use by the Regional Teams in this screening evaluation.

Travel times should be estimated for both technologies for both local and express service. For dwell times at intermediate stations, two minutes per station stop was assumed. All train running times include a six-percent "schedule recovery time" based on European ~~HSR~~high-speed train practice.

Table 4.2-1
Example Travel Time Worksheet

Segments			Local Travel Time							Express Travel Time					
Stations		Length	Max V	Ta	Tv	Td	Tss	Tt*	Avg V	Max V	Ta	Tv	Td	Tt*	Avg V
Begin	End	km	km/h	min	min	min	min	min	km/h	km/h	Min	min	min	min	km/h
SD	MM	16.1	250	2.7	1.4	2.2	0.0	6.7	145	250	2.7	2.5	0.0	5.5	175
MM	Esc	23.7	250	2.7	3.3	2.2	2.0	10.7	133	250	0.0	5.7	0.0	6.0	236
Esc	Tem	47.1	325	3.5	5.5	2.9	2.0	14.7	192	325	0.0	8.7	0.0	9.2	307
Tem	Riv	60.5	325	3.5	8.0	2.9	2.0	17.3	210	325	0.0	11.2	0.0	11.8	307
Riv	Ont	28.8	250	2.7	4.5	2.2	2.0	12.0	144	250	0.0	6.9	0.0	7.3	236
Ont	ESG	25.9	250	2.7	3.8	2.2	2.0	11.3	138	250	0.0	6.2	0.0	6.6	236
ESG	LA	40.6	250	2.1	10.2	1.8	2.0	17.1	142	200	0.0	11.3	1.8	13.8	176
Total Length =		**242.6**	Total Travel Time (min) =					**89.8**		Total Travel Time (min) =				**60.3**	
Notes: Ta – acceleration time Tv – time at max velocity Td – deceleration time Tss – station stopping time Tt* - total travel time including 6% schedule recovery										SD – San Diego MM – Mira Mesa Esc – Escondido Tem – Temecula		Riv - Riverside Ont - Ontario ESG – East San Gabriel LA – Los Angeles			

B. POPULATION/EMPLOYMENT CATCHMENT

The amount of population and/or employment within a defined area surrounding a potential station option will serve as an indicator of ridership potential. This measurement will be applicable in comparing station options a significant distance apart (> five miles [eight kilometers]). Population and employment information should be quantified based on the best available data (e.g., regional travel demand model, census data). Previous studies defined the catchment area as within a 20-mile (32.2-kilometer) radius of the station, except in cases where two stations were within 20 miles (32.2-kilometers) of each other, in which case a 10-mile (16.1-kilometer) radius catchment area was assumed.

4.2.2 Connectivity and Accessibility

Stations serve as the only point of access or connection to the proposed ~~HSR~~high-speed train system. The selection of station locations is one of the key considerations that will affect the relative effectiveness and efficiency of the proposed ~~HSR~~high-speed train service. The number of and spacing between stations and local access to these sites are critical to the trade-off between system accessibility to riders and line haul travel time. The location of the stations with respect to travel markets and transportation infrastructure, the ease and availability of intermodal access to and from the station, and the travel time to and from the station can be critical determinants of system performance. Each of these factors should be considered and described qualitatively as part of the evaluation of each station location option. These factors should be quantified to the extent possible at this conceptual level of detail to support the qualitative discussion. Specifically, number of intermodal connections available and their proximity to the station option should be quantified at each station option considered.

4.2.3 Capital Cost Estimating

Capital cost estimating should follow the methods and assumptions defined and applied in the previous corridor evaluation. In that study, the capital costs were categorized into discrete cost elements. In general, the capital costs were estimated by determining the appropriate unit costs for the identified cost elements and the cost element quantities from conceptual ~~HSR~~high-speed train alignment plans. Each cost element is defined below along with the methods and assumptions applied in each case. Many of these elements have recently been reviewed as part of the Peer Reviews of the Corridor Evaluation commissioned by the Authority. Some of the assumptions contained herein may be revised prior to the detailed evaluation of alternatives in the next stage of this program. However, application of these assumptions will be consistent with past evaluations and will provide appropriate level of detail for the comparison of alignment and station options at this screening level.

A. ALIGNMENT COSTS

Track and Guideway Items

~~HSR~~High-Speed Train Track/Guideway: for steel rail systems (VHS), this includes ballast, subballast rails, ties, fasteners, and special trackwork (turnouts, sidings, etc.). For maglev systems, this consists of the guideway beams including glide surfaces, guidance rails, and stator packs (electrically powered linear motor built directly into the guideway which generates the propulsion for the maglev system). The track required in the maintenance and service facilities, as well as the at-grade or elevated reinforced concrete substructures/foundation guideway costs, including switches, within maintenance and service facilities are included in the cost of the those facilities.

Track/guideway unit costs were applied per unit length of alignment. For the rail technologies, separate unit costs were applied to account for lengths of ballasted track section and direct fixation (slab track). Separate unit costs were applied to account for maglev at-grade and elevated guideway construction. Special trackwork costs were estimated based on the length of the segment and the need for special track/guideway features, such as turnouts, crossovers, etc. Special trackwork costs were estimated at 15 percent of total track/guideway costs.

Earthwork and Related Items

Included in the detailed categories below are all the earthwork elements and other items related to site development.

Site Preparation: the costs for "clearing and grubbing" which cover the removal of unsuitable surface debris, and removal of vegetation. This also includes the cost of "grading" which is the movement of dirt around the site to prepare the surface for construction. Site preparation also includes work done to make the site usable after the demolition of existing structures.

Unit costs for site preparation were applied to the total area required for earthwork operations along a given segment. The amount of area was based on the earthwork volume calculations.

Earthwork: the general category of "earthwork" is made up of four constituent activities: excavation, embankment, spoil, and borrow. Earthwork incidental to the construction of a structure, such as the excavation for a bridge foundation, would not be included here -- that cost is a part of the structural estimates.

Unit costs of earthwork were applied to the total volume of earthwork required along a given segment. A digital terrain model was used to calculate the earthwork volumes based on the profile of each segment.

Landscaping: for areas alongside the tracks/guideways within the HSR right-of-way. Plantings in station areas are included under passenger stations. The landscaping along the route includes the seeding of cut slopes and embankments.

Fencing: a security chain link fence 8 feet (2.5 meters) in height along the right-of-way. All at-grade sections, cut and fill sections, tunnel portals, maintenance areas, and any other areas where tracks are accessible to public will be fully fenced. A unit cost for fencing was applied per length of alignment.

Drainage Facilities: includes culverts and other structures needed for track/guideway and cross drainage purposes only, including track underdrains if needed. This does not include the cost of bridges or bridge drainage costs. The cost of drainage facilities was estimated at five percent of the cost of earthwork for each segment.

Structures, Tunnels and Walls

Structures are defined as those appurtenant elements that require structural engineering for system design, and fall into the categories below. Buildings (such as passenger terminals and maintenance facilities) are not included under structures but are in other elements.

Viaducts and Bridges: costs for prestressed reinforced concrete aerial structures include the bridge, as well as the abutment (for a bridge or viaduct). Cost for that bridge would consist of the excavation for the abutment including all wing walls and transition slabs. The foundation work would also be included as well as the earthwork needed to construct the foundations. Waterway crossings that were calculated on a per crossing basis are included under bridge costs.

It should be noted that in California a similar structural section is expected to be required for both maglev and VHS technologies -- since aerial structure design for both are controlled by the same seismic loading combination, accessibility, and serviceability requirements. In geographical areas of lower seismicity (outside our study area), other loading combinations (e.g., live load) may control. Under those conditions, the lower live load of maglev vehicles over rail vehicles may result in a reduction of construction costs for aerial structures.

A unit cost was applied per length of aerial structure. Different unit costs were used for standard aerial guideway and special structures requiring spans greater than 120 feet (36.6 meters), and for heights exceeding 30 feet (9.1 meters).

~~HSR~~ High-Speed Train Tunnels: tunnel boring machine (TBM) and drill and blast (D&B) tunnels constructed beneath the ground level that only require surface occupation (construction access) at the openings of the tunnel. The costs for these tunnels for the ~~HSR~~high-speed train system include all structural work, ventilation systems, electrical systems related to tunnel (such as lighting, fans, etc.), special drainage, etc. needed to make the tunnel ready to receive the railroad. This item does not include the track, signaling or traction power systems. Unit costs were applied per length of single and double track tunnel sections.

Seismic Chambers: an oversized tunnel segment to accommodate track realignment and passage of the train subsequent to a major fault rupture event where an especially large displacement is expected.

Retaining Walls: used to support embankments and retained fill along cut sections (retaining walls that are a part of abutments for bridges are included in the bridge costs).

Crash Walls: structural walls (including foundations and walls) required to prevent incursion of vehicles from one area to another. Generally, they are included whenever the ~~HSR~~high-speed train track/guideway is at-grade and adjacent to (within 30 feet [9.1 meters]) existing freight and passenger rail operations on dedicated ~~HSR~~ portions of the high-speed train line (or alternative). Crash walls are also required adjacent to existing structures where prescribed by horizontal clearances (Ref. Caltrans Bridge and American Railway Engineering and Maintenance-of-Way Association [AREMA] Standards).

Sound Walls: walls used only for sound mitigation, including all foundations and appurtenances needed for their support. Sound walls are included in segments where adjacent land uses warrant their use. For a given segment, the amount of sound wall required was based on the percentage of developed land uses along that segment. This sound mitigation cost (cost of walls/mile [walls/meter]) was estimated separately from, and in addition to, the environmental mitigation cost (factor of line construction cost).

Grade Separations

Bridges and Undercrossings: highway and railroad overcrossings/undercrossings of the ~~HSR~~high-speed train system. All crossings with other transportation facilities must be grade-separated from the ~~HSR~~high-speed train system. The unit costs applied for these grade separations include all of the cost elements necessary to complete the construction of the grade separations, such as earthwork, traffic handling, drainage, etc. The number of existing crossings (roadway and rail) per segment was quantified per USGS planimetric information, field reconnaissance and other mapping sources according to type (at-grade, under or over) and size (primary, secondary and minor roadways). Judgments were made regarding the proposed crossing type, including the option of closure for minor roadways, and costs were calculated on a per-crossing basis.

Building Items

Passenger Stations: platforms, circulation, lighting, security measures and all auxiliary spaces including intermodal connection areas. Spaces are provided within the station for ticket sales, passenger information, station administration, baggage handling, and a reasonable amount of commercial space for newsstands, restaurants, etc. Different station facility unit costs were applied to four separate station classifications: terminal, urban, suburban and rural. The different unit costs account for differences in station size, configuration and general location. These costs are assumed to be a rough average, since station costs are expected to vary widely at specific locations.

These average station costs per category will not be useful in the comparison of station options in this screening evaluation. Since the size requirements of the stations do not vary per specific station location option, the right-of-way costs and major physical constraints will be the key differentiating factors in the comparison of individual station location options. Regional Teams should apply local right-of-way cost information as the primary cost comparison factor for this screening effort. Major physical constraints should be identified and the associated effects on capital cost should be discussed qualitatively and quantified to the extent possible. More detailed station construction unit costs will be applied in subsequent evaluations.

Site Development & Parking: the paving, parking structures and landscaping of the site around the passenger station building. Also included is the provision of street and roadway modifications necessary to provide access to the site. Different site development unit costs were also applied to the four station classifications: terminal, urban, suburban and rural.

Rail and Utility Relocation

Railroad Relocation: the cost of track relocations (temporary or permanent) required to place HSR track/guideway into existing rail corridors, including all construction work needed to relocate the railroad, including earthwork, trackwork, etc. A unit cost was applied to the length of alignment requiring relocation.

Utility Relocation: the cost of major utility relocations that must be done before constructing the facilities, such as: overhead power lines, pipelines, sewers and fiberoptics and underground ductbanks. Different unit costs were applied to the total length of alignment based on the intensity of land use development along the alignment.

B. RIGHT-OF-WAY ITEMS

The total cost associated with the purchase of land and/or easement rights for the HSR system. This includes relocation assistance and demolition costs. Property values and acquisition costs can range from quite modest in undeveloped areas, to quite significant in areas where high-value commercial properties near the stations are needed. In some cases, the cost of acquisition services may equal or exceed the cost of the property itself. These costs include those for title searches, appraisals, legal fees, title insurance, surveys, and various other processes.

The cost estimates assume that a minimum right-of-way width of 50 feet (15.2 meters) is necessary throughout the length of each segment. Even when the alignment is primarily within existing rail rights-of-way, costs are estimated to account for the purchase and or lease agreements necessary for operation in these corridors. Wider right-of-way sections are necessary in mountainous areas where large cut and fill slopes are required.

Three general parameters were followed: (1) a minimum right-of-way corridor of 50 feet (15.2 meters) has been assumed in congested corridors; (2) a 100-foot (30.4-meter) corridor has been assumed in less developed areas to allow for drainage, future expansion and maintenance needs; and (3) a wider corridor was assumed in variable terrain to allow for cut and fill slopes.

The Regional Teams should review the unit costs applied in the previous study realizing that they were applied on an overall average basis. For the purposes of this screening, right-of-way unit costs should be revised as necessary in each region to reflect local market conditions.

C. ENVIRONMENTAL IMPACT MITIGATION

This cost is total cost associated with mitigation of environmental impacts such as wetland replacement, parkland mitigation, and biological resource/habitat replacement or enhancement. Noise mitigation with sound walls and right-of-way impact and relocation mitigation are estimated separately as defined above.

The total cost of environmental mitigation was estimated to be three percent of the line construction costs (i.e. track, earthwork, structures, etc.) for each segment, based on other recently implemented transportation corridors in California. The environmental mitigation cost per length of track/guideway is anticipated to be the same for both VHS and maglev systems.

This factor is applied on the average to estimate a total cost of mitigation. It is not useful as a distinguishing factor in the screening evaluation. The potential environmental impacts are evaluated as part of the environmental criteria in Section 4.3.

D. SYSTEM ELEMENTS

Signaling and Communications Items

Signaling: These costs cover the cost of wayside, on-board and central control software and hardware for the overall signaling system. The unit costs are applied per length of track/guideway. The VHS technologies operate either on the basis of moving block technology with automatic train protection (ATP) or automatic train control (ATC) and automatic train operation (ATO).

Communications: includes a high capacity fiber optic backbone with full redundancy, which is key for the operation of the Supervisory Control and Data Acquisition (SCADA) and reliable ATC systems. The communication system will be used for operations; maintenance and emergencies; phone and fax capabilities (enroute); closed circuit television; public information systems; public address systems; and other monitoring and detection devices needed for a safe and efficient operating system. The unit costs are applied per length of track/guideway.

Wayside Protection Systems: includes systems/equipment to monitor and/or detect obstacles that may be placed or fall onto the track/guideway; intrusion; flooding; wind; seismic activity and equipment failures (broken rails, hot axles, dragging equipment, etc.). The unit costs are applied per length of track/guideway.

Electrification Items

Traction Power Supply: This cost is the entire cost of the substations, including site preparation; foundations; cable trenches; fencing; electrical equipment, etc. The unit costs are applied per unit length of track/guideway. It does not include the cost of transmission lines from the local utility source to the substations; those are included in the energy costs, a part of the operating and maintenance costs. These costs are different for VHS and maglev.

Traction Power Distribution: This cost is for VHS systems, which includes the catenary poles and foundations; the catenary wires and supports; tensioning devices; power feeders and returns; transformers and other appurtenances. For maglev systems, it includes the power transmission cables and control equipment along the guideway as well as the 3-phase longstator cable windings (mounted in the stator packs on the underside of the guideway). The unit costs are applied per unit length of track/guideway.

E. VEHICLE AND SUPPORT FACILITY COSTS

The capital costs associated with vehicles and support maintenance facilities will not be included in this screening evaluation. They will be addressed in the next stage of this program.

F. PROGRAM IMPLEMENTATION COSTS

Costs for these elements are computed as a percentage of the total of construction and procurement costs. The percentages are intended to represent the average overall cost of these implementation items, based on implementation of rail transit and other related improvement projects throughout the state. The percentages are predicated on a Design-Build (DB) and

Design-Build-Operate-and-Maintain (DBOM) procurement approach and would be significantly higher using a traditional procurement approach. These costs would be divided between the owner and the contractor in this procurement approach and are noted accordingly. These costs are not useful in the screening evaluation; however, they should be maintained in the cost estimates for overall consistency in the order of magnitude.

Preliminary Engineering and Environmental Review: These are preliminary engineering design costs to approximately a 35 percent level. This will indude geotechnical investigations; land surveying and mapping; engineering; architecture; landscape architecture; traffic engineering; right-of-way engineering and preparation of preliminary plans and analyses in all necessary technical disciplines; and various other technical studies and support of the draft environmental document. The environmental review would entail all studies and analyses necessary to complete both federal and state required environmental documents. (Owner - 2.5 percent)

Program & Design Management: Costs for the overall management and administration of the project. Included were the Program Manager's office, contract management and administration, project control including both cost and schedule, general administration, computer support, quality assurance, configuration management, system safety, publications, public relations, support of the bidding process, agency liaison, community information and involvement and legal support. (Owner - 5.0 percent)

Final Design: Costs for final design and preparation of construction and procurement documents for all facilities and systems. This will include geotechnical investigations; land surveying and mapping; engineering; architecture; landscape architecture; traffic engineering; right-of-way engineering; preparation of plans and specifications in all necessary technical disciplines; and various other technical studies and support of the final design process. Design support during construction, including shop drawing review is also included in this item. (Contractor - 5.0 percent)

Construction & Procurement Management: Costs for all management of construction and procurement work after contracts are awarded to contractors or suppliers. This will include on-site inspection in factory and field, quality control, contract administration and acceptance inspection. (Owner – 1.0 percent; Contractor – 4.0 percent)

Agency Costs: The costs of maintaining the owner's organization during the entire program, whether that owner is a franchisee or a government agency. (Owner - 1.0 percent)

Force Account Costs: Costs for the services of other organizations or agencies of local, state or federal government that may be required to support the project. Work within railroad rights-of-way may be on force account with the appropriate railroad. There may be unforeseen costs as a result of moving the railroad to allow for HSR. (Owner - 1.0 percent)

Risk Management: The costs of owner-supplied insurance or any other allowances decided to be applied for the management of risk to the owner. (Owner - 6.0 percent)

Testing & Pre-Revenue Operations: The costs of pre-revenue testing, acceptance testing, safety certification and training related to start-up of the system for revenue service. These costs would be included in the DBOM contract. These costs are not included as part of the program implementation costs for this screening evaluation.

G. CONTINGENCIES

A contingency is added as a percentage of overall project costs -- based on past experience for projects in early stages of definition. Contingencies should not be considered as potential savings. They are an allowance added to a basic estimate to account for items and conditions that cannot be assessed at the time of the estimate. The contingency amount is expected to be reduced as the project matures. The contingency is estimated at 25 percent of the total of construction costs.

H. UNIT COSTS

Unit costs were developed for each cost element described above. The unit costs are presented by cost element in Appendix C.

4.3 ENVIRONMENTAL EVALUATION CRITERIA

The environmental constraints and impacts criteria, while meeting the objectives outlined in Table 4.1-1, will focus on environmental issues that can affect the location or selection of alignments and stations. These are organized into five overall environmental categories as outlined below.

Table 4.3-1
Environmental Evaluation Criteria

Category	Criteria
Land Use	▪ Land Use Compatibility and Conflicts ▪ Visual Quality Impacts
Natural Resources	▪ Water Resources Impacts ▪ Floodplain Impacts ▪ Wetlands Impacts ▪ Threatened & Endangered Species Impacts
Social and Economic Resources	▪ Environmental Justice (Demographics) ▪ Community & Neighborhood Impacts ▪ Farmland Impacts
Cultural Resources	▪ Cultural Resources Impacts ▪ Parks & Recreation/Wildlife Refuge Impacts
Engineering and Environmental Constraints	▪ Soils/Slope Constraints ▪ Seismic Constraints ▪ Hazardous Materials/Waste Constraints
Public/Institutional Constraints	▪ Public/Political/Institutional Issues

In addition to the environmental issues listed above, Regional Teams may identify other issues that could affect the location and selection of alignments and stations specific to their regional study area. In those cases, each Regional Team should document the reasons for evaluation and the methodologies employed in the Regional High-Speed Rail Alignment/Station Screening Evaluation Report.

To identify potential impacts for the alignments and station locations, a number of readily available baseline digital data sources will be provided for use with ESRI-compatible Geographic Information System (GIS) software (ArcView v.3.2 or ArcInfo v.8.02). Digital data includes SPOT 10-meter resolution satellite imagery (available for 1999/2000) and USGS Digital Raster Graphics (DRGs) (1:24,000 and

1:100,000), which may be used as base map information. Digital data specifically pertinent to each topic is identified in the methodology that follows. GIS data will be provided to the Regional Consultant Teams for use in the evaluation of alignments and stations created in a CAD/MicroStation environment. Refer to Appendix D for a brief description of GIS standards and procedures (refer to Task 1.9, GIS Data Management Plan for a complete discussion of the GIS protocols). Teams are encouraged to update/supplement the baseline data with more detailed data, if available, with the understanding that the data will be the property of the Authority at the end of the project along with Federal Geographic Data Committee- (FGDC-) compliant metadata. Additional information will have to be obtained by the Regional Teams as part of the project including general plans (all elements and community plans) from the jurisdictions traversed by the corridors and regional planning documents. All documents obtained for the project will also become the property of the Authority.

For evaluation of alignments and stations, right-of-way widths dictated by engineering requirements should be utilized (refer to Section 3.2.8). Right-of-way should be used to identify the amount of area within each segment containing certain characteristics. These segment widths should be used for the water resources, floodplains analysis; parks, recreation areas and wildlife refuges analysis; farmlands; land use compatibility analysis; and the hazardous materials/waste analysis. Other environmental issues will use various buffer widths that extend beyond the conceptual right-of-way for the segments. For consistency between Regional Studies, each buffer width has been identified based upon the specific analysis needs of the environmental issue and is described in Section 4.3.1 within each specific evaluation methodology.

While some of the evaluation can occur through the use of the data sources provided, field reconnaissance will be required to view on-the-ground conditions and to provide relative values of certain resources. Generally this field investigation will take the form of "windshield" surveys. In cases where the alignment is not generally visible from the nearby roadway network, other methods should be used, such as high-rail vehicles or aerial reconnaissance. However, "walking" the entire alignment should not be necessary at this level of analysis. The methodologies used for analyzing the potential environmental impacts are identified below.

Certain environmental regulations require a demonstration that avoidance alternatives have been evaluated when there are impacts to publicly-owned land from a park, recreation area, or wildlife or waterfowl refuge, or land from a historic site eligible for or listed on the National Register of Historic Places (Section 4[f] of the Department of Transportation Act); wetlands (Executive Order 11990); and floodplains (Executive Order 11988). According to Section 4(f) of the Department of Transportation Act, the Secretary of Transportation may approve a federal transportation project only if there is no feasible and prudent alternative to the use of such land, and; the proposal includes all possible planning to minimize harm to the Section 4(f) land resulting from such use. Executive Order 11990 (wetlands) requires federal agencies to refrain from giving financial support or other assistance to projects that will encroach upon public or private wetlands unless the agency finds that there are no reasonable alternatives to the proposed project and that the proposed project includes all reasonable mitigation recommendations to minimize the adverse effects of the project. Executive Order 11988 (floodplains) directs all federal agencies to avoid all short-term and long-term adverse impacts associated with floodplain modification and to avoid direct and indirect support of development within 100-year floodplains whenever there is a reasonable alternative available. When evaluating these three types of resources based on the limited level of information available for screening, the Regional Teams should clearly document why certain segments/stations have been screened from further evaluation.

4.3.1 Environmental Screening Methodology

A. LAND USE

<u>Land Use Compatibility and Conflicts</u>

Existing development throughout the state varies widely from dense urban areas to suburban areas to farmlands. Land use compatibility and conflicts include consideration of proximity impacts on adjacent land uses, such as noise, vibration, and visual impacts along segments and traffic and air quality impacts at stations. Potential land use conflicts may arise from siting a HSR alignment or stations within residential areas, near schools, and adjacent to parks and recreational areas among others. For this evaluation stations are considered to include the station, platforms, parking facilities, and ancillary facilities.

Utilizing the SPOT images provided in the GIS Database, digital land use data, general plans, and field reconnaissance, the Regional Teams should evaluate land use compatibility and conflicts for alignments and stations as discussed below.

Alignment

- The best land use compatibility scenario for siting HSR alignments was identified to be within or along designated transportation or utility corridors. The Regional Teams need to identify the dominant general land uses within and adjacent to the proposed segment. Existing land use classifications for this evaluation should include transportation/utility corridors, recreational, open space/undeveloped, farmland, institutional (schools, hospitals, churches, libraries, military), commercial, office, industrial, and residential. In areas of mixed uses, classify as mixed use, but identify those uses that are most common.

Stations

- The adjacent circulation network around proposed stations should be qualitatively evaluated to identify if sufficient roadway capacity exists to support the station. If not, the Regional Teams need to identify what measures may be required to handle traffic in and around proposed stations.
- Identify if the location of a station would lead to conversion of adjacent land uses that would be incompatible with general plan land uses (e.g., conversion to commercial uses in areas not planned for such uses). It should be assumed that commercial development would be induced near stations. This should be evaluated against the general plans and other policy documents to identify incompatibility. Any conflict with these policy documents would be considered potentially significant.
- Identify station locations that would provide for intermodal connections. This would be considered to be a potentially compatible land use scenario.

Visual Quality Impacts

HSR projects, which are typically large, linear elements that traverse various types of terrain, land use, water features, vegetation, and development, can often have a substantial visual effect. The effects can be adverse or beneficial. The public acceptance of a proposed transportation improvement is often dependent upon the public's understanding and acceptance of its visual quality effects.

The U.S. Department of Transportation developed guidelines for assessing visual impact of transportation facilities, particularly highways. The methodology applied in the evaluation of the HSR corridors utilized this method to identify areas where there may be the potential for visual quality impacts. The methodology considers the visual impact of HSR for all viewer groups, including adjacent land users (views of the project) as well as HSR users (views from the train). Potential physical changes to the environment, such as cuts/fills, elevated structures, water crossings, and loss of major vegetation and urban development need to be identified. In addition, those viewers who would be sensitive to visual changes, such as residents, park users, and travelers along the proposed facility should also be identified. To conduct the evaluation, USGS DEMs should be used to identify the topography and areas of cuts, fills, tunnels, and elevated structures. GIS data gathered for other components of this study, including water crossings, populated areas, and parks and recreational resources should also be utilized.

The location and type of sensitive "first-row" viewers should be identified and overlaid on the HSR segments. First-row viewers are the nearest viewers that can see the alignment or other potential project elements. In urban areas, this is probably the adjacent properties, if they are sensitive (as defined above). In more open or rural areas, the first row receivers may be located some distance away. (Note: The sensitive viewers from the train should be assumed for the entire segment and do not have to be further identified.)

In addition, the location and type of potential major physical changes (cut/fill slopes, aerial structure, tunnel portals, station locations, etc.) should be identified and overlaid on the HSR segments. Areas with sensitive first-row receivers and potential major physical changes is the area where there is a high potential for visual impacts.

Highly sensitive visual resources that would be visible from the segments (and would, thus, have views of the segments) should be identified. These would include such resources as scenic highways, wild and scenic rivers (as defined by the Wild and Scenic Rivers Act of 1968), scenic overlooks or viewpoints, National Park land and State Park land, wilderness areas (as defined by the Wilderness Act of 1964), etc. Review local general plans and other policy documents to identify locally important visual resources.

B. NATURAL RESOURCES

Water Resources Impacts

Water resources for this stage of environmental evaluation include streams, rivers, lakes, and sensitive natural drainage basins or watersheds (surface flow). Identifying water resources is important to comply with federal and state laws requiring that these resources be identified and impacts to them avoided or minimized. HSR corridors should avoid or minimize effects to watersheds or natural drainage patterns. Water resources are also identified to minimize degradation of water quality.

Using the USGS hydrographic features in the GIS Database, the number of water resources crossed by a segment should be quantified to identify the level of potential impact. In urbanized areas, it is likely that many of the crossings are channelized or otherwise improved, rather than natural. Impacts would be considered greater for crossings of natural streams and rivers and watersheds compared to previously improved channels because of potential wetland and sensitive habitat impacts. The Regional Teams should delineate watersheds and drainage patterns and note the name of the water crossings (when known), whether they are natural or improved.

Floodplain Impacts

Floodplains are defined as the area subject to flooding by a 100-year flood. A 100-year flood is caused by a storm of general intensity and duration that would be expected to have a one-percent chance of occurrence in any given year.

To identify the potential location of areas within the 100-year floodplain, the Regional Teams should utilize the Federal Emergency Management Agency digital Federal Insurance Rate Maps. The number of floodplain crossings and the total length of the crossings should be quantified. The Regional Teams need to document if other segment alternatives were evaluated that <u>may</u>

avoid or minimize impacts to floodplains. A floodplain evaluation will be part of the subsequent detailed technical studies along with a more detailed evaluation a reasonable avoidance alternatives.

Wetland Impacts

Wetlands serve important purposes relating to fish and wildlife, recreation, and other elements of the general public interest. The U.S. Army Corps of Engineers (Corps) and the Environmental Protection Agency (EPA) regulate fill of wetlands. As environmentally vital areas, they constitute a productive and valuable public resource; the unnecessary fill of wetlands or alteration should be discouraged as contrary to the public interest. Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Data from the National Wetlands Inventory (NWI) has been included in the California HSR GIS Database. Based upon NWI data availability, these maps do not provide full coverage of the entire high-speed rail study area. The Regional Teams should utilize other wetlands data at their disposal and document source and date of the information used. This information should be supplemented with information on sensitive wetland habitats recorded in the California Natural Diversity Database (CNDDB). The number of wetland crossings should be quantified and the potential value of the wetlands assessed and documented (i.e., is the wetland part of a larger system of wetlands, are the wetlands part of a wildlife refuge or sanctuary, are there institutional restrictions on constructing in the wetlands). This evaluation will not identify all wetlands likely to be encountered within a segment, but rather should quantify potential for impacts to previously identified wetlands. The Regional Teams need to document if other segment alternatives were evaluated that may minimize impacts to wetlands (at the screening level, only the previously identified wetlands [by others] will be known and true avoidance or minimization will not be known). The Regional Teams should note any special cases where wetlands are suspected which could affect the siting of alignments or stations and discuss at a qualitative level. Wetlands delineations will be part of the subsequent detailed technical studies along with a more detailed evaluation a reasonable avoidance alternatives.

Threatened and Endangered Species Impacts

Protection of plant and animal species of special concern have been afforded recognition by federal, state, or local resource conservation agencies, organizations and/or jurisdictions. These include species listed as rare, threatened, and/or endangered by resource conservation agencies such as the U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG).

The threatened and endangered species analysis will be based on information obtained from the California Natural Diversity Database (CNDDB), contacts with CDFG Natural Heritage Division and USFWS, information from available published literature, and existing documentation of special status species and habitats in the project area. The database is not complete or definitive, but it includes most of the species that would be required to be addressed under both the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA). The Regional Teams should identify observations of threatened and endangered species and sensitive habitat areas traversed (information on sensitive habitat areas can be obtained from the local resource agencies). Field surveys are not required for this analysis. Locations of special status species and their habitats are approximate and are subject to change as a result of seasonal variation, local land use changes including urbanization and development and other disturbances. The Regional Teams should identify and list the threatened and endangered species within the right-of-way or directly adjacent to the segments and station areas. The number of species is not important, but is an indication of potential species to be encountered. Those species or habitat that would require special mitigation or coordination with resource agencies should be documented. More detailed surveys will be part of the subsequent detailed technical studies.

C. SOCIAL AND ECONOMIC RESOURCES

Environmental Justice (Demographics) Impacts

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires federal agencies to take the appropriate and necessary steps to identify and avoid "disproportionately high and adverse" effects of federal projects on the health or environment of minority and low-income populations. The California HSR Project would be required to comply with Executive Order 12898. The evaluation will identify minority and low-income populations within close proximity of the corridors rather than disproportionate impacts, which will be conducted as part of detailed technical studies.

To evaluate the potential for disproportionate effects on populations, the GIS Database information from the 1990 U.S. Census (census block groups) should be used to identify low-income and minority populations within a 1,400-foot (426.72-meter) buffer. A 1,400-foot (426.72-meter) buffer (700 feet [213.26 meters] either side of the center of the right-of-way) encompasses areas that would be directly affected due to displacement from the acquisition of right-of-way, and areas outside the right-of-way that could be indirectly affected by noise, vibration, and visual.

Block groups are the smallest area for which census information has been aggregated. The boundaries for block groups have been included in the GIS database. The buffer encompasses areas that would be directly affected due to potential displacement from the acquisition of the right-of-way, and areas outside the right-of-way that could be indirectly affected by project-related noise, vibration, and other indirect effects. The first variable, percent population below the poverty level, should be based on 1989 household income and includes all persons in households with incomes below a threshold of $12,674 for a family of four. The population below the poverty level was calculated for all census block groups in the study area. The second variable included in this assessment is the population that is non-white, including Hispanic, which is a multi-racial group. Those block groups where the minority or low-income populations exceed 50 percent should be identified as areas where there may be the potential for disproportionate impacts.

Community and Neighborhood Impacts

Community and neighborhood impacts include disruption to neighborhoods and physical barriers or divisions of established communities that would affect those who live or work in the area.

Utilizing the SPOT images, general plans, and field reconnaissance, the Regional Teams should identify areas where segments have the potential to divide or disrupt communities or neighborhoods. Segments that extend within or adjacent to existing corridors or rights-of-way would be less likely to divide or result in barrier effects. If segments lie within a new corridor, then field review would be required to identify areas that may be divided or separated from other parts of the neighborhood or community. Also note if there is the potential to affect community resources or activity centers. The Regional Teams should identify places where facilities would be separated from the community they serve. Community resources can include police and fire stations, libraries, hospitals, recreational facilities, churches, neighborhood shopping areas, schools, and beaches, among others.

Farmland Impacts

Farmlands include Prime Farmland, Unique Farmland, and Farmland of Statewide Importance. Prime Farmland is that which can economically produce sustained high yields of basic crops such as food, feed, forage, fiber, and oil seed. Unique Farmland is land other than Prime Farmland or Farmland of Statewide Importance that is currently used for production of specific high value food and fiber crops. Farmland of Statewide Importance is land other than Prime Farmland that has a good combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oil seed crops.

Digital farmland mapping has been obtained from the U.S. Natural Resources Conservation Service (NCRS) (formerly the Soil Conservation Service) and uploaded into the California HSR GIS database. Potential impacts to Prime Farmland, Unique Farmland, and Farmland of Statewide Importance should be quantified by number of acres within each HSR segment and station location using the engineering right-of-way widths. The Regional Teams should also use the SPOT data to identify and quantify the number of locations where there are obvious divisions of farmland parcels or parcels that would become isolated and not suitable for continued farming or agricultural use.

D. CULTURAL RESOURCES

Cultural Resources Impacts

Cultural resources include historic properties, bridges, districts, and archaeological sites and sites that could be considered sacred to Native American groups. Impacts to these resources fall under several federal laws, including Section 106 of the National Historic Preservation Act and Section 4(f) of the Department of Transportation Act. These laws require consideration of effects to historic properties listed in or eligible for the National Register of Historic Places and specifically consideration of feasible and prudent avoidance alternatives under Section 4(f). In addition, CEQA requires mitigation, if feasible, of properties listed on the National Register, the California Register of Historic Resources, or otherwise identified as of local cultural importance.

Cultural resources data for the analysis were developed principally from the GIS database provided by the National Parks Service on National Register resources. The California Register and any local registers should also be checked. The regional California Historical Resources Information System (CHRIS) files should be reviewed for known archaeological and other cultural resource sites. Potential impacts to cultural resources should be identified and quantified for those resources within the HSR segment right-of-way width. While conducting the evaluation, cultural resources within close proximity (first row receiver [see Visual Quality Impacts discussion]) but not actually in, the assumed right-of-way that may be affected by HSR operation should also be identified.

Parks and Recreation/Wildlife Refuge Impacts

Section 4(f) of the United States Department of Transportation Act of 1966 affords protection to certain cultural resources and parks and recreational areas. Section 4(f) resources include publicly owned land in a public park, recreation area, or wildlife and waterfowl refuge of national, state or local significance as determined by federal, state or local officials having jurisdiction over such resource. Impacts on these resources are critical to assess because of their federal protection. Section 4(f) requires consideration of feasible and prudent avoidance alternatives and measures to minimize harm.

For this analysis parks, recreation areas, and refuges should be identified and input to the California HSR GIS database as point information (include name, address, city, owner, type of facility), using published maps and general plans (if electronic information is unavailable). Parks, recreation areas, and wildlife refuges potentially affected should be identified and quantified by overlaying the alignment and station right-of-way. While conducting the evaluation, resources that are within close proximity (first row receiver [see Visual Quality Impacts discussion]) but not actually in the assumed right-of-way that may be affected by HSR operation should be identified.

E. ENGINEERING/ENVIRONMENTAL CONSTRAINTS

Soils/Slope Constraints

Soils and slope constraints include soils with high erodibility, soils with a high propensity to shrink or swell under certain soil moisture conditions, and steep slopes (slope greater than nine percent). Avoidance of these areas is important because of safety, stability of structure concerns, construction difficulty, and cost of mitigation.

Soil data, the State Soil Geographic (STATSGO) data was obtained from the U.S. Department of Agriculture. The STATSGO data broadly identifies soil types and properties within the state, including erodibility and shrink/swell potential. The STATSGO data should be used to identify erodibility and shrink/swell potential.

Slopes can be identified in GIS using the USGS Digital Elevation Models (DEMs). Slopes are classified into five categories: 0 to 4 percent, 5 to 8 percent, 9 to 15 percent, 16 to 25 percent, and greater than 26 percent. The area of erodible soils, shrink/swell soils, and steep slopes (greater than 9 percent) within the right-of-way should be quantified for each segment.

Seismic Constraints

Identifying the location of known active seismic areas and faults is important in developing adequate HSR safety measures, as well as construction and operational mitigation. To do this, the distribution and nature of known active faults and potentially damaging seismogenic sources along each of the segments must be identified.

A number of data sources will have to be utilized to identify fault crossings: California Division of Mines and Geology (CDMG) and the USGS, published reports and papers, CDMG Fault Evaluation Reports, and data from the Working Group for Northern California Earthquake Potential (NCEP). The active fault crossings for HSR segments should be quantified and discussed. General plans and other sources should be reviewed for information about other seismic hazards that might affect the segments, such as mapped areas of liquefaction potential, landslide potential, subsidence or uplift potential, etc. If seismic information is unavailable electronically, faults crossing the HSR segments should be input to the GIS Database.

Hazardous Materials/Waste Constraints

Known hazardous materials/waste sites are considered constraints to be avoided. It is state policy, in the development of transportation projects, to fully consider and avoid, wherever possible, all potential aspects of hazardous materials/waste. Not only can encountering hazardous materials/waste affect the project costs and schedule, but it can also create the potential of exposure of people or the environment to hazardous materials/waste. Materials that constitute hazardous waste include petroleum products, pesticides, organic compounds, heavy metals, or other materials injurious to human health and the environment.

To evaluate the potential sites a statewide database was obtained from VISTA Information Solutions Inc. The segment right-of-way widths should be used in the hazardous materials/waste analysis.

The number of potential hazardous waste sites will need to be quantified for each segment. Major sites or sites likely to require extensive remediation should be identified.

F. PUBLIC/INSTITUTIONAL CONSTRAINTS

Public/Political/Institutional Issues

Public, political, and institutional issues that may affect the siting of HSR alignments and location of stations need to be considered early in the planning process and documented in the Regional HSR Alignment/Station Screening Evaluation Report. These issues may be those expressed at Town Hall meetings, Authority Board meetings, or through political leaders, organizations/groups, or known by Program Manager and the Regional Teams based on past projects.

Each Regional Team needs to briefly document the public, political, and institutional issues associated with the various alignments (or segments if there are concerns) and station locations that may affect the selection of a HSR alignment and stations that will be evaluated in the Program EIR/EIS.

5.0 ALIGNMENT/STATION SCREENING EVALUATION DOCUMENTATION

5.1 REGIONAL ALIGNMENT/STATION SCREENING EVALUATION OUTLINE

The outline in Table 5.1-1 and following instructions are to be used for the Regional High-Speed Rail Alignment/Station Screening Evaluation Report. This outline will be utilized for all regions so that relevant information is consistently documented for each corridor for ready incorporation into a Statewide High-Speed Rail Alignment/Station Screening Evaluation Report developed by the Program Manager.

Table 5.1-1
Regional High-Speed Rail Alignment/Station Screening Evaluation Report Outline

Section	Contents
S.0	Summary
TABLE OF CONTENTS	Table of Contents, List of Tables, List of Figures
1.0	Introduction • Purpose • Background
2.0	Assumptions/Parameters and Evaluation Methodology • Assumptions/Parameters • Evaluation Methodology
3.0	Alignment and Station Definition • Previous Alignment and Station Options Studied • Confirmation of Reasons Options Screened from Further Analysis • Additional Alignment and Station Options Studied
4.0	Alignment and Station Evaluation • ~~Confirmation of Reasons Options Screened from Further Analysis~~ • Alternative Alignment and Station Option Comparison
5.0	References
6.0	Persons and Agencies Consulted
7.0	Preparers
APPENDICES	Attachments

5.2 REGIONAL ALIGNMENT/STATION SCREENING EVALUATION REPORT INSTRUCTIONS

Discussed below are the instructions for preparing the Regional High-Speed Rail Alignment/Station Screening Evaluation Report. The Program Manager will provide a sample report format, style sheet, referencing requirements, and map, figure, and table formats that will be used for this and all other reports.

S.0 SUMMARY

Provide a brief summary of the following sections for inclusion as a section in the Statewide High-Speed Rail Alignment/Station Screening Evaluation Report. Use the Attainment of Objectives table (Appendix E) to summarize to the attainment of objectives of the various alignment/station options (this table summarizes the Evaluation Matrix, also in Appendix E, and discussed in Section 4.0 below).

TABLE OF CONTENTS
Prepare a table of contents, list of tables, and list of figures.

1.0 INTRODUCTION
The Program Manager will provide a brief description of project background, history, and purpose according to information provided in this Screening Methodology Report. Regional Teams will describe the regional context as part of an overall statewide ~~HSR~~high-speed train system.

2.0 ASSUMPTIONS/PARAMETERS AND EVALUATION METHODOLOGY
Provide a summary of key system parameters including design guidelines, operating assumptions, unit costs, and other planning assumptions applied to the region as well as the specific options evaluted. The methodologies used in the evaluation process should be discussed. Most of t~~T~~his chapter will be provided by the Program Manager and will~~should~~ reference the information presented in this Screening Evaluation Methodology~~, ~~. Regional Teams will describe ~~but focus on~~ unique issues or additional assumptions made in each particular region.

3.0 ALIGNMENT AND STATION DEFINITION
Briefly describe the alignments and stations from previous studies that were re-evaluated. Identify and define additional alignments and stations that were considered for high-speed train service as part of this Screening Evaluation. Describe why some options were screened from further analysis based on previous studies or re-evaluation. Be specific about "why" the previous alignments and stations have been removed from consideration.

4.0 ALIGNMENT AND STATION EVALUATION
Describe ~~why some options were screened from further analysis based on previous studies or re-evaluation. Be specific about "why" the previous alignments and stations have been removed from consideration.~~and d~~ D~~ocument the analysis of new alignment and station options according to the methodologies defined in the Screening Methodology Report. Identify and discuss any unique aspects of the application of the methods in the specific regional context. Present the information for the various alignment and station options for each evaluation criteria in the evaluation matrix located in Appendix E (the evaluation criteria will be summarized in the attainment of objectives table discussed above in Section S.0).

5.0 REFERENCES
Provide documentation of references.

6.0 PERSONS AND AGENCIES CONSULTED
List all persons and agencies consulted or contacted during the report.

7.0 PREPARERS
List the preparers for the report and provide the name, company, title, and role in analysis.

APPENDICES
Attach all relevant appendix material and letter starting with "Appendix A".

6.0 ALIGNMENT/STATION SCREENING EVALUATION ASSISTANCE

The Program Manager will provide technical assistance to Regional Teams and the California High-Speed Authority throughout the project as required.

It is recognized that there is a high level of knowledge among all team members. This combined asset will best serve the needs of the project through open sharing of knowledge and communication. This document is provided to ensure Regional Team product consistency that will enable the Program Manager to prepare a statewide high-speed train alignment/station screening evaluation summary. Contact information for the Program Management Team is provided below for any questions that arise during this screening evaluation.

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7.0 PREPARERS

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Marilyn Duffey The Duffey Company	30 years of experience managing interdisciplinary environmental teams and preparing environmental studies; involved with five U.S. high-speed rail projects. • Environmental Manager • Quality Control
Paul Taylor Kaku Associates, Inc.	M.S., Civil Engineering, Massachusetts Institute of Technology (MIT); B.S., Civil Engineering, MIT. 30 years of experience in managing and conducting transportation planning, multi-modal, and engineering studies. • Planning Manager • Quality Control
Melissa Cutter Parsons Brinckerhoff Assistant Civil Engineer	B.S., Civil Engineering, University of California, Irvine. • Engineering Criteria • Screening Methodology Documentation
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APPENDICES

APPENDIX – A
Typical Cross Sections

APPENDIX – B
Travel Time Estimating Worksheets

APPENDIX – C
Unit Cost Table

Appendix C
Unit Cost Table

Item No.	Item Description	English		Metric	
		Unit	Unit Price	Unit	Unit Price
Track and Guideway Items					
1	HS/VHS Track – Ballasted	mile	$1,257,000	km	$781,000
2	HS/VHS Track - Direct Fixation	mile	$2,376,000	km	$1,477,000
3	Maglev - At Grade Slab & Track Beam	mile	$5,303,990	km	$3,295,600
4	Maglev - Track Beam (Aerial and Tunnel)	mile	$3,487,130	km	$2,166,750
5	Special Trackwork (VHS)	%	15% of Mainline Trackwork	%	15% of Mainline Trackwork
6	Special Trackwork (UHS)	%	15% of Mainline Trackwork	%	15% of Mainline Trackwork
Earthwork and Related Items					
1	Site Preparation	acre	$3,850	hectare	$9,500
2	Earthwork	Cu-yd	$5.35	Cu-m	$7.00
3	Imported Borrow	Cu-yd	$8	Cu-m	$10.50
4	Landscaping/Erosion Control	acre	$2,570	hectare	$6,350
5	Fencing (Both Sides of R/W)	mile	$144,000	km	$80,000
6	Drainage Facilities	%	5% of Earthwork Cost	%	5% of Earthwork Cost
Rail and Utility Relocation					
1	Existing R/R Relocation	mile	$1,609,000	km	$1,000,000
2	Utility Relocation - Dense Urban	mile	$1,127,000	km	$700,000
3	Utility Relocation – Urban	mile	$861,000	km	$535,000
4	Utility Relocation - Dense Suburban	mile	$604,000	km	$375,000
5	Utility Relocation – Suburban	mile	$346,000	km	$215,000
6	Utility Relocation – Undeveloped	mile	$17,700	km	$11,000
Building Items					
1	Terminal	LS	$88,000,000	LS	$88,000,000
3	Site Development/Parking (Terminal Station)	LS	$22,000,000	LS	$22,000,000
2	Urban	LS	$44,000,000	LS	$44,000,000
4	Site Development/Parking (Urban Station)	LS	$11,000,000	LS	$11,000,000
5	Suburban	LS	$22,000,000	LS	$22,000,000
6	Site Development/Parking (Suburban Station)	LS	$5,500,000	LS	$5,500,000
7	Rural	LS	$11,000,000	LS	$11,000,000
8	Site Development/Parking (Rural Station)	LS	$2,200,000	LS	$2,200,000
Structures/Tunnels/Walls					
1	Standard Aerial Structures	mile	$17,284,000	km	$10,800,000
2	Special Aerial Structures	mile	$47,283,000	km	$29,550,000
3	Cut and Cover Tunnels	mile	$33,730,000	km	$20,960,000
4	Double Track Tunnels – Drill and Blast	mile	$38,530,000	km	$23,940,000
5	Double Track Tunnels - Mined (soft soil)	mile	$103,400,000	km	$64,270,000
6	2 Single Track Tunnels - Drill and Blast	mile	$75,640,000	km	$47,000,000
7	2 Single Track Tunnels - Tunnel Boring Machine	mile	$50,600,000	km	$31,440,000
8	Seismic Chamber	EA	$60,680,000	EA	$60,680,000
9	Retaining Walls	mile	$5,570,000	km	$3,460,000
10	Crash Walls	mile	$1,900,000	km	$1,180,000
11	Sound Walls	mile	$724,000	km	$450,000

Appendix C
Unit Cost Table (continued)

Item No.	Item Description	English		Metric	
		Unit	Unit Price	Unit	Unit Price
Grade Separations					
1	Under Crossing - (Dense Urban, Urban)	EA	$14,100,000	EA	$14,100,000
2	Over Crossing - (Dense Urban, Urban)	EA	$13,500,000	EA	$13,500,000
3	Under Crossing - (Dense Suburban)	EA	$5,400,000	EA	$5,400,000
4	Over Crossing - (Dense Suburban)	EA	$5,100,000	EA	$5,100,000
5	Under Crossing - (Suburban, Undeveloped)	EA	$910,000	EA	$910,000
6	Over Crossing - (Suburban, Undeveloped)	EA	$860,000	EA	$860,000
7	Close Existing At Grade Crossing	EA	$140,000	EA	$140,000
8	Waterway Crossing – Primary	EA	$5,400,000	EA	$5,400,000
9	Waterway Crossing – Secondary	EA	$2,700,000	EA	$2,700,000
10	Irrigation/Canal Crossing	EA	$320,000	EA	$320,000
Right-of-Way					
1	Right-of-way – Dense Urban (50' Corridor)	mile	$7,920,000	km	$4,920,000
2	Right-of-way – Urban (50' Corridor)	mile	$5,280,000	km	$3,280,000
3	Right-of-way – Dense Suburban (50' Corridor)	mile	$2,640,000	km	$1,640,000
4	Right-of-way – Suburban (100' Corridor)	mile	$1,848,000	km	$1,150,000
5	Right-of-way – Undeveloped (100' Corridor)	mile	$1,320,000	km	$820,000
Environmental Impact Mitigation					
1	Environmental Mitigation	%	(3% of Construction)	%	(3% of Construction)
Signals and Communication					
1	Signaling (ATC) – VHS	mile	$1,070,000	km	$665,000
2	Communications -VHS (w/Fiber Optic Backbone)	mile	$885,000	km	$550,000
3	Signaling (ATC) - Maglev	mile	$1,239,000	km	$770,000
4	Communications - Maglev (w/Fiber Optic Backbone)	mile	$885,000	km	$550,000
5	Wayside Protection Systems (VHS & Maglev)	mile	$85,000	km	$52,800
Electrification					
1	Traction Power Supply - VHS	mile	$547,000	km	$340,000
2	Traction Power Distribution - VHS	mile	$1,020,000	km	$634,000
3	Traction Power Supply - Maglev	mile	$1,030,000	km	$640,000
4	Traction Power Distribution - Maglev	mile	$3,927,000	km	$2,440,000

APPENDIX – D
GIS Standards

California High-Speed Train Program EIR/EIS GIS Standards

GIS data will be provided to project teams for use in analysis. Teams are encouraged to add more detailed data layers as appropriate for their studies with the understanding that these additional layers will be given to the High Speed Rail Authority at the end of the project along with FGDC compliant metadata for each layer.

The project projection will be UTM, zone 11, NAD83 with units in meters. Any additional data turned over to the Authority will be done so in this projection.

All GIS data will be compliant with standard ESRI software, and with standards for the California High Speed Rail GIS database. This includes:

- The inclusion of FGDC compliant metadata for each data layer, including all layers created for the project, before returning data to PB or the ~~HSR~~HIGH-SPEED TRAIN Authority.
- Be projected to UTM, zone 11, NAD83, with units in meters.

Route data layers are given as both a shape file and as an Arc route. Routes will be created for each corridor in the study area and be post-miled from south to north, and from east to west. It is expected that the route networks will be cleaned so that there are no unnecessary dangles or similar errors. Naming standards will adhere to those conventions given with the data.

More detailed information has been documented in Task 1.9, GIS Data Management Plan.

APPENDIX – E
Regional Evaluation Tables

Table S.#-#
(Region Name) – High-Speed Train Alignment/Station Attainment of Objectives

Objective	Alignment Option 1	Alignment Option 1A	Alignment Option 2	Alignment Option 2A	Station Option 1	Station Option 2	Station Option 3	Station Option 4
Maximize Ridership/ Revenue Potential	●	○	◕	◔	◕	●	◔	○
Maximize Connectivity and Accessibility	○	○	○	○	◕	●	○	◑
Minimize Operating and Capital Costs								
Maximize Compatibility with Existing and Planned Development								
Minimize Impacts to Natural Resources								
Minimize Impacts to Social and Economic Resources								
Minimize Impacts to Cultural Resources								
Maximize Avoidance of Areas with Geologic and Soils Constraints								
Maximize Avoidance of Areas with Potential Hazardous Materials								

Examples shown in blue text. "Ranksym" font used for symbols. This font is provided on ProjectSolve (www.projectsolve.com):

PROJECT FILES\Working Library\All Teams\Standard Fonts & Graphics

○ ◔ ◑ ◕ ●

Least Favorable Most Favorable

Table 4.#-#
(Region Name) High-Speed Train Alignment/Station Evaluation Matrix

Evaluation Criteria	Alignment Option 1	Alignment Option 1A	Alignment Option 2	Alignment Option 2A	Station Option 1	Station Option 2	Station Option 3	Station Option 4
Maximize Ridership/Revenue Potential.								
Travel Time	10 min.	17.8 min.	13 min.	19 min.	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	●	◑	◕	○	○	○	○	○
Length	20 miles (32.2 km)	50 miles (80.4 km)	30 miles (48.3 km)	45 miles (72.4 km)	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	●	○	◕	◔	○	○	○	○
Population/Employment Catchment	Not Applicable	Not Applicable	Not Applicable	Not Applicable	3,000 persons	5,000 persons	1,800 persons	1,500 persons
	○	○	○	○	◕	●	◔	○
Maximize Connectivity and Accessibility.								
Intermodal Connections	Not Applicable	Not Applicable	Not Applicable	Not Applicable	• LAX – 16 mi. (25.7 km) • Freeways– 4 mi (6.4 km) • MTA Bus • Metrolink	• LAX – 10 mi. (16 km) • Freeways • Amtrak • MTA Bus • MTA Rail • Metrolink	• LAX – 20 mi. (32.2 km) • Freeways	• Burbank – 1 mi. (1.6 km) • Freeways– 4 mi. • MTA Bus • Metrolink
	○	○	○	○	◕	●	○	◑
Minimize Operating and Capital Costs.								
Length								
Operational Issues								

Examples shown in blue text. "Ranksym" font used for symbols. This font is provided on ProjectSolve (www.projectsolve.com):

PROJECT FILES\Working Library\All Teams\Standard Fonts & Graphics

Evaluation Criteria	Alignment Option 1	Alignment Option 1A	Alignment Option 2	Alignment Option 2A	Station Option 1	Station Option 2	Station Option 3	Station Option 4
Construction Issues								
Capital Cost								
Right-of-Way Issues/Cost								
Maximize Compatibility with Existing and Planned Development.								
Land Use Compatibility and Conflicts								
Visual Quality Impacts								

Evaluation Criteria	Alignment Option 1	Alignment Option 1A	Alignment Option 2	Alignment Option 2A	Station Option 1	Station Option 2	Station Option 3	Station Option 4
Minimize Impacts to Natural Resources.								
Water Resources								
Floodplain Impacts								
Threatened & Endangered Species Impacts								
Minimize Impacts to Social and Economic Resources.								
Environmental Justice Impacts (Demographics)								
Farmland Impacts								

Evaluation Criteria	Alignment Option 1	Alignment Option 1A	Alignment Option 2	Alignment Option 2A	Station Option 1	Station Option 2	Station Option 3	Station Option 4
Minimize Impacts to Cultural Resources.								
Cultural Resources Impacts								
Parks & Recreation/Wildlife Refuge Impacts								
Maximize Avoidance of Areas with Geologic and Soils Constraints.								
Soils/Slope Constraints								
Seismic Constraints								
Maximize Avoidance of Areas with Potential Hazardous Materials.								
Hazardous Materials/Waste Constraints								

Evaluation Criteria	Alignment Option 1	Alignment Option 1A	Alignment Option 2	Alignment Option 2A	Station Option 1	Station Option 2	Station Option 3	Station Option 4
Minimize Public, Political, and Institutional Conflicts.								
Public/Political/Institutional Issues								

Least Favorable ○ ◔ ◑ ◕ ● Most Favorable